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AN ANALYSIS OF THE CONCEPT OF HYPOTHESIS USED BY WRITERS IN SECONDARY SCHOOL SOCIAL STUDIES

by

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ABSTRACT

The intention of this study was to investigate the coverage of the concept, hypothesis, by writers of social studies inquiry theory and methodology. Since inquiry is now generally considered an integral part of the "new social studies," and the process of hypothesizing a crucial part of inquiry, it is held that those who stipulate criteria for use of the concept should be aware of its complexity and major requirements. To gain an indication of this awareness, writers of social studies theory and methodology were analyzed in regard to their descriptions of, and prescriptions for, the use of hypothesis. The analysis was limited to a representation of publications produced in North America since 1960.

It was realized that to carry out this analysis a means of measurement was necessary. An analysis of various writers in the area of logic and thought analysis, dealing with what was--in the study--classified as the scientific or "systematic" hypothesis, was made. From this analysis a schema, centered around the three main components of function, origin, and structure outlined by John Dewey, was constructed. This schema served to summarize the analysis as well as provide a means of measurement for assessing the coverage of the concept, hypothesis, by social studies writers. The productions of these writers were then analyzed by identifying

the occurrence of schema points. The points were totaled individually and collectively, each writer being rated accordingly. These findings were then summarized and totaled to rate both writers and actual publications, as well as to assess general coverage of the various schema points.

On the basis of the requirements indicated by the schema, it was revealed that the treatment of the concept by these social studies writers was generally inadequate. Though some of the individual schema points seem to be stressed, it was noted that the component of structure is relatively neglected.

The gravity of the situation respecting the need for both these writers and their audience to become aware of a possibly very significant lack was then noted. In conclusion, implications of the findings for social studies inquiry and all education and learning in general were made.

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THE PROBLEM

PROBLEM STATEMENT

Because of the increasingly prominent status accorded the inquiry approach in social studies education, the concept, hypothesis, is acquiring greater significance. This significance is due to the central position held by the concept in inquiry. Thus, there is need for establishing maximum clarity for definition, analysis, and use of the concept.

It is invariably the theorist who exerts the greatest influence on the general conceptualization and use of a concept of this nature. Hence, the present study is concerned with the following problem: In the context of inquiry in the secondary school social studies, how adequate is the conceptualization and use of the concept, hypothesis, by writers of social studies theory or methodology who have produced work in Canada and the United States since 1960?

SIGNIFICANCE OF THE STUDY

Any conceptual or descriptive study should be concerned with the significance and viability of the proposed analysis or description. Why analyze the concept, hypothesis, and interpretations of it? Why look at this particular

concept? How can concentration on merely one aspect of the inquiry process be justified? The answer has primarily to do with the fact that hypothesizing is considered central and crucial to inquiry.

It is considered important to establish that hypothesizing is a basically standard process, irrespective of the general intellectual process in which it might be employed. That is, hypothesizing, where used in inquiry, whether in the context of education's pedagogical and learning theory--reflective thinking, critical thinking, problem-solving, or discovery--or the "scientific" method of even the natural sciences, is essentially uniform. Generalizability within and amongst the thought processes just mentioned, and hence a certain validation of the present study depends on recognition of the standard nature of the "scientific" hypothesis.

Significance is, however, best revealed by placing the emphasis on the crucial role of hypothesis formulation. One writer, Stebbing, supplies the major significance of the concept by stating its primary role.

> If we are interested in the process whereby scientific discoveries are made, we can hardly over-emphasize the part played by the formulation and development of hypotheses. An hypothesis is a proposition suggested by the evidence available to establish the conclusion, but insufficient to demonstrate the conclusion. Hypotheses are formed when we seek to ask why something has happened.[1]

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[1]C. W. Mundle (review), A Modern Elementary Logic, by Lizzie S. Stebbing (London: Methuen, 1952), p. 180.

Supporting its central function from another perspective, William Burton states,

> A hypothesis, or several of them, is necessary as a guide in seeking facts, even in determining what are facts in some instances. Ordinarily it is impossible to get facts, even to find and consult sources of fact without a hypothesis to guide the search.[2]

Massialas provides an educational application:

> . . . the hypothesis serves the dual role of search model and criterion of relevance. The use of hypothesis as the focus of discussion distinguishes the reflective classroom from the traditional.[3]

The real significance and full impact of an hypothesis is shown by what Popper has to say,

> In the imaginative episode we form an opinion, take a view, make an informed guess, which might explain the phenomena under investivation. The generative act is the formation of an hypothesis: "We must entertain some hypothesis," said Peirce, "or else forego all further knowledge," for hypothetical reasoning is the only kind of argument which starts a new idea.[4]

Huxley states,

> Those who refuse to go beyond fact rarely get as far as fact. . . . Almost every great step (in the history of science) has been made by the "anticipation of nature," that is, by the invention of hypotheses which, though verifiable, often had very little foundation to start with.[5]

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[2]William Henry Burton, Education for Effective Thinking; an Introductory Text (New York: Appleton, 1960), p. 63.

[3]Byron Massialas and Benjamin C. Cox, Inquiry in Social Studies (New York: McGraw-Hill, 1966), p. 113.

[4]Sir Peter Brian Medawar, Induction and Intuition in Scientific Thought (Philadelphia: Memoirs of the American Philosophical Society, 1968), p. 46.

[5]Morris R. Cohen and Ernest Nagel, An Introduction to Logic and Scientific Method (New York: Harcourt, Brace, and Company, 1934), p. 167.

Kerlinger provides a statement that might be considered a suitable summary of the foregoing: "It can almost be said that the hypothesis is the most powerful tool man has invented to achieve dependable knowledge."[6] It could thus be said that the hypothesis is necessary for the very creation and extension of knowledge.

Finally, John Dewey is quoted as he, in his familiar five step problem-solving process, places hypothesizing at the core of any rigorous thinking activity.

> The third element of thinking (learning) is a search for hunches, leads, tentative hypotheses. The whole process of framing and testing hypotheses until a satisfactory route to the goal has been reached is the heart [italics not in the original] of the problem solving process.[7]

Thus, the importance of the proposed analysis largely lies in the crucial nature of the concept to be studied.

Recognizing the focal position of the concept in both logical analysis and empirically-based scientific modes of inquiry, an extensive knowledge of hypotheses, particularly of their construction, must be rated vital to productive and generative thought. It thus becomes essential to know the "formula" for the creation of a hypothesis. Does such a formula exist? If not, should one be developed? To lay down rigid rules would no doubt prove too restricting, but that certain transcending guidelines may be applied seems quite

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[6]Fred Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, 1964), p. 27.

[7]John Dewey, How We Think (Boston: Heath, 1933), p. 168.

apparent. Dewey writes,

> The facts, or data, which constitute the working material of hypotheses are regarded as given to all alike, and all alike are more or less interested in systematizing and unifying experience. The purpose of the hypothesis and the opportunity for forming it are thus practically the same for all, and hence certain definite rules can be laid down which will apply to all cases where hypotheses are to be employed.[8]

Respecting the proposed study, what is being considered here is a form of validity. To analyze the concept, hypothesis, and the use of hypothesis it is necessary to possess certain standards or criteria. Unless basis on such standards is possible, the validity of the proposed analysis must be questioned. A researcher, Buchanan, in a study entitled Logics of Scientific Discovery, concurring with most authorities in the area concludes that a logic of discovery as such is not possible. But, Buchanan concedes the following:

> An examination of N. R. Hanson's work on discovery suggests that he is searching for criteria by which the reasonableness of suggested hypotheses may be judged, as well as for methods for formulating hypotheses.[9]

Buchanan apparently found some difficulty in formulating methods of hypothesis formation, but did find that hypothesis formation is not necessarily beyond the bounds of methods. "Criteria of reasonableness" are considered as a possible

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[8]John Dewey, Studies in Logical Theory (Chicago: University of Chicago Press, 1903), p. 145.

[9]Bruce Gardner Buchanan, "Logics of Scientific Discovery," Dissertation Abstracts, Humanities and Social Sciences, 28 (1966), 256A.

alternative to a logic of discovery. As well, several conditions are discussed which a set of rational methods for formulating hypotheses should be expected to approach. Requirements of consistency with accepted theory, ability to explain the data, testability, simplicity, and projectibility are considered the more important.[10]

On the basis of the authority of the foregoing pronouncements, as well as the exposition of criteria and methodology by many writers, the plan of producing a type of conceptual schema for hypothesis and hypothesizing is being deemed legitimate, enhancing the validity of the proposed analysis.

Prerequisite to analyzing the place of the concept, hypothesis, in social studies inquiry, however, is the understanding of the significance and role of that very inquiry. The inquiry method, in theory if not in practice, has largely come to displace the traditional lecture-discussion method as the more popular approach in social studies education. The point is well made by Edgerton.

> Clearly, "the new social studies" favors an emphasis on methods of inquiry. This emphasis becomes obvious upon examination of recently published textbooks for prospective social studies teachers. The titles of these texts alone are indicative of the new look. For example, there are: Clements, Fielder and Tabachnick's *Social Study: Inquiry in Elementary Classrooms*; Massialas and Cox's *Inquiry in Social Studies*; and Fenton's *Teaching the New Social Studies in Secondary Schools: An Inductive Approach.*[11]

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[10] *Ibid*.

[11] Stephanie G. Edgerton, "Symposium: 'Learning' By Induction," *Social Education*, XXXI (May, 1967), 374.

Cox and Cousins perhaps perceive the situation most accurately:

> About a generation ago an emphasis emerged on critical thinking and the problems approach in social studies. Recently, the stress in these instructional elements has shifted to their intellectual aspects.[12]

Now, the inseparability of the two processes, inquiry and hypothesizing, is made explicit by Sagl.

> Inquiry, in essence, is a process in which children zero in on a problem and hypothesize and formulate theories that get at the areas of why and how. The focus is not on established generalizations but on theories that predict what would happen when put to the test.[13]

It follows then that hypothesizing, if it can be considered the "heart" of the inquiry method, will progressively increase in significance as inquiry gains increasing recognition as a valid pedagogical and learning method in the field of social studies.

The importance of defining and knowing how to use a hypothesis has been discussed, but implications of this importance in education can only be perceived in a study of the concept's application. No attempt will be made to analyze the actual use of hypotheses, but it is important to note that many writers emphasize the need for teaching

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[12]Benjamin Cox and Jack Cousins, "Patterns of Student Behavior in Reflectively Oriented Classes," Readings on Social Studies in Secondary Education, ed., Jonathon C. McLendon (New York: Macmillan, 1966), p. 239.

[13]Helen Sagl, "Problem-solving, Inquiry, Discovery?" Childhood Education, XLIII (November, 1966), 138-39.

students how to hypothesize (Woodburn;[14] Miklos and Miklos;[15] Cleaver;[16] Bruner;[17] Fenton;[18] and Massialas[19]). Woodburn goes so far as to say that "fortunately, the hypothesis is the most stimulatingly rewarding phase of a science lesson for both the teacher and his students. This is true for several reasons, one being the basic nature of the hypothesis."[20] Normally it is stressed as well that the student must employ basically the same methodology as the scientist (Wronski[21] and Woodburn[22])--in the case of social studies, the social scientist.

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[14]John A. Woodburn, "The New Social Studies--Crossroads to Success Versus Failure in Science and Science Teaching," School, Science and Math, LXIX (April, 1969), 333.

[15]Miklos and Miklos, op. cit., pp. 114-15.

[16]T. J. Cleaver, "Inquiry Objectives in Curriculum Development; B.S.C.S.--McRel Document," American Biology Teacher, XXXII (November, 1970), 478.

[17]Jerome S. Bruner, "The Elements of Discovery," Inquiry in the Social Studies; Theory and Examples for Classroom Teachers, eds., Rodney F. Allen, John U. Fleckenstein, and Peter K. Lyon (Washington: N.C.S.S., 1968), p. 25.

[18]Edwin Fenton, The New Social Studies (New York: Holt, Rinehart and Winston, 1967), p. 11.

[19]Byron Massialas, "Teaching History as Inquiry," The Social Studies; Structure; Models and Strategies, eds., Martin Feldman and Eli Seifman (Englewood Cliffs: Prentice-Hall, 1969), p. 238, citing Columbia Associates in Philosophy, An Introduction to Reflective Thinking (Boston: Houghton Mifflin, 1923).

[20]Woodburn, loc. cit.

[21]Stanley P. Wronski, "A Proposed Breakthrough for the Social Studies," Readings on Social Studies in Secondary Education, ed. Jonathan C. Mclendon (New York: Macmillan, 1966), p. 271.

[22]Woodburn, loc. cit.

In summary, in recognizing the regard paid to the capacity to hypothesize, and in realizing that use at the implementation level will strongly reflect production of educationalists in the field of social studies curriculum and methodology, the investigator considers the significance of this study to be well established.

NEED FOR THE STUDY

What of related research done in the area of inquiry or problem-solving? From a comprehensive review of such research it is apparent that the concern has been with determining the effects, and hence direct educational value, of inquiry. Types of inquiry or problem-solving methods are frequently compared. Seldom, if at all, has research dealt with the process itself, analyzing the separate components involved. A researcher, O'Conner, speaking from the perspective of science education had this to say of the matter:

> Although much research . . . has been concerned with problem-solving, it has dealt mainly with various aspects of the latter, and measured the outcomes rather than the processes involved.[23]

Another writer, Cleaver, also recognizes this fundamental lack. Concerned with inquiry development in curriculum he talks of a type of activity that he terms an "inquiry factor": namely, "inquiry into inquiry."[24]

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[23]Terence O'Conner, "The Problem-Solving Processes of High School Students in Physics" (unpublished thesis, New York: University of New York, 1959), p. 29.

[24]Cleaver, loc. cit.

Yet even though there is some recognition of a definite lack in this regard, relatively few writers seem to recognize the underlying reason for this lack. The problem seems to be that the exact nature of this mental phenomenon, inquiry, is difficult to define or delineate. And, of course, to turn the causal link about, this difficulty is precisely why more research into the processes involved is necessary. Nonetheless, the object of research must be clear before research can prove fruitful. This need for clarity, in connection with research of the components of inquiry, is aptly described by Lee and Steiner:

> It is well understood by scientists that tools or instruments for gathering information are important to the success of their research efforts. As more precise and more sophisticated instruments have been developed for gathering scientific information, the quality of the research product has been improved. In a similar way satisfactory instruments for gathering information in educational research are necessary to the success of that endeavor. In science education, for example, very little objective information has been obtained assessing the success of science programs in providing for an understanding of the process of science. One major factor that, in part, has limited evaluation in this area is that components of inquiry have not been clearly identified.[25]

Massialas and Zevin referring to the same problem from a different perspective express what is being considered the basis for this very study:

> The lack of a clear understanding of the means and ends of inquiry is further illustrated within the context of secondary school social studies. The curriculum

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[25]A. E. Lee and H. E. Steiner, Jr., "Research Potential of Inquiry Objectives; McRel--B.S.C.S. Document," American Biology Teacher, XXXII (December, 1970), 544.

> of the secondary school presents to the student certain bodies of knowledge under the labels of history, sociology, economics and the like.[26]

Almost appearing as a direct rejoinder, is Metcalf's statement that ". . . it is already clear that the traditional course in methods of teaching will have to give more attention than it has to the logical foundations of method."[27]

In applying this obstacle of vagueness more directly to the present study, the question of how the use of hypothesis and the process of hypothesizing can be assessed without a knowledge of certain requirements becomes a major one. Katsoff refers to this very deficiency:

> One of the most intriguing phases of scientific procedure is the nature, role and origin of the hypothesis. Actually if one examines any discussion of scientific method, he would find no hint at all concerning how to construct or find a "good" hypothesis.[28]

A more general but associated problem is that of a lack of consensus amongst writers in the relevant literature. This situation has no doubt contributed to the rather haphazard state of research and thought on not only the problem-solving process, including hypothesizing, but most any form of structured thinking or reasoning. This major

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[26]Byron G. Massialas and Jack Zevin, "Teaching Social Studies Through Discovery," Social Education, XXVIII (November, 1964), 301.

[27]Lawrence Metcalf, "The Reflective Teacher," Teaching the Social Studies, What, Why, and How, eds., Richard E. Gross, Walter E. McPhie, and Jack R. Fraenkel (Scranton, Pa.: International Textbook Company, 1969), p. 240.

[28]L. O. Kattsoff, "The Role of Hypothesis in Scientific Investigation," Mind, LVIII (1949), 222.

shortcoming is alluded to by Bloom and Rakow in a reference they make to the higher mental processes (including reflective thinking or problem-solving):

> . . . this is a difficult field to organize. The terms are different for different workers, the studies are rarely cumulative or even addressed to common problems, and only recently have workers in the field been meeting each other in face-to-face conferences.[29]

The result of all this is that theory on thinking processes is rather inadequate and inconclusive. Bloom and Rakow state:

> Theory and systematic research on thinking do lag--but efforts to improve the thinking of students do not. The higher mental processes are rapidly becoming the central objectives of instruction at all levels of education. Achievement tests and aptitude tests are constructed to measure thinking and problem solving. And teachers, everywhere, are determined that their students will think. People do think and schools do try to develop better capabilities of thinking in their students. No one seems to wait for theory and research to tell them what to do or how to do it. Perhaps it is fortunate, considering the state of theory and research in this field, that action is far ahead of thought.[30]

In view of the situation, this study has attempted, as one major task prior to the main analysis, to produce a systematic schema of principles relating to hypothesis formation.

The other aspect of need arises from the fact that a standard scientific hypothesis does exist and should, therefore, prove applicable to all inquiry, whatever its form. From this standpoint, then, any discrepancy or

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[29]Benjamin S. Bloom and Ernest A. Rakow, "Higher Mental Processes," Encyclopedia of Educational Research, ed., Robert L. Ebel (4th ed., New York: Macmillan Company, 1969), p. 600.

[30]*Ibid.*

incongruity between the "scientific" hypothesis and that used in social studies inquiry would mean inconsistency, involving the problem of non-generalizability. It should be added that recognition by theorists and researchers of the possibility of such incongruency appears very limited. An exception is revealed in a statement made by a researcher, Aylesworth, who, in reference to what another writer, Lampkin, has to say of a problem in science education, writes:

> He implied that when the scientific attitudes as listed by philosophers and those attitudes mentioned by professional science educators who were also general science textbook authors are compared, some disagreement is found. Inasmuch as scientific attitudes and the ability to solve problems . . . are intertwined, there seems to be some inconsistency in these statements.[31]

As evidenced by the lack of concern amongst researchers and other writers for, first of all, the "infant" state of theory on thinking and thought products, and secondly, the possibility of real ambiguity and incongruency of treatment amongst inherently unvarying scientific modes of inquiry, a definite need exists in regard to the clarification of meaning (in its fullest sense) necessary for the concept, hypothesis, in social studies theory and practice.

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[31]Thomas G. Aylesworth, "Problem-solving: A Comparison of the Expressed Attitudes With the Classroom Methodology of Science Teachers in Selected High Schools (unpublished Master's Thesis, Ohio: Ohio State University, 1959), p. 5.

DEFINITION OF TERMS

1. Inquiry process: . . . is generally the process of identifying, exploring and validating *alternatives*.[32] It involves both deductive and inductive processes as they apply to questions of fact and value (Massialas). . . . is the active, persistent, and careful consideration of any belief or supposed *form of knowledge* in the light of the grounds that support it and the further conclusions to which it tends (Dewey).

2. Problem-solving: . . . is the process of exploring and testing alternative *hypotheses* to solve an indeterminate situation or problem (Massialas). . . . is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole (Dewey). . . . [is] . . . a process . . . of discovery or educing new relationships among things observed or sensed; the process includes conscious or subconscious assumption, or *hypothesis*, of a possible relationship within a simple or complex system of thought and understanding, and means to test through experience the acceptability of the assumption (Good).

3. Scientific method: . . . is the systematic, extensive, and carefully controlled use of alert and unprejudiced

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[32]Italics within definitions have been supplied to indicate the position of hypothesizing in the various processes.

observation and experimentation in collecting, arranging, and testing evidence. . . . [involves] . . . raising a question, analyzing relevant theories, producing a hypothesis, collecting and interpreting necessary data, arriving at conclusions and producing operative generalizations (Dewey). . . . [entails] . . . procedures or operations used to acquire and systematize knowledge concerning things and phenomena experienced in observation and experiment, or to test hypotheses (propositions) or assertions about the empirical world (Good).

4. Hypothesis: . . . [is] . . . a tentative conjecture assigning provisionally a cause for known facts, to be used as a basis for their arrangement and classification and as a starting point for experiment and investigation which, by the discovery of new facts, may uphold or disprove the conjecture, and aid in reaching the true theory (Standard Dictionary). . . . [is] . . . a guiding idea, tentative explanation, or statement of probabilities, serving to initiate and guide observation and the search for relevant data and other considerations and to predict certain results or consequences (Good). . . . is a tentative and provisional thesis put forward upon the basis of accumulated knowledge for the guidance of further investigation and research. The word is derived from the Greek hypo (under) and tilhenai (to place), and suggests that when the hypothesis is placed under the evidence as a foundation, they lend each other mutual support. It performs this function by providing a proposed explanation which will have certain consequences deducible

from it. These consequences may then be confirmed or refuted by further testing or experimentation (Searles).

5. Social studies: . . . [involves] . . . those portions of the subject matter of the social sciences, particularly history, economics, political science, sociology, and geography, which are regarded as suitable for study in elementary and secondary schools and are developed into courses of study, whether integrated or not, and of which both the subjected matter and the aims are predominantly social; not to be confused with the social sciences or subjects having a social aim but not social content (as in courses of English, art appreciation, and personal health), nor to be confined to too narrow or rigid a combination of studies (Good).

6. Secondary schools: . . . are those schools which in North American education normally include grades seven through twelve inclusive, as distinct from the elementary schools which usually involve grades one through six.

7. Methodology: . . . is the science of method, or orderly arrangement; specifically, the branch of logic concerned with the application of the principles of reasoning to scientific and philosophical inquiry (Webster).

DESIGN OF THE STUDY

Basically, the investigator was aiming to assess the validity of the description and usage of the concept, hypothesis, and the process of hypothesizing within

theoretical foundations for inquiry in the social studies. It was held that this assessment could only be carried out on the basis of some reasonably reliable and standard form of measurement. Hence, the first task involved the construction of a rigorous and viable definition and explanation of the concept, hypothesis. This was accomplished by constructing a synthesis of the more comprehensive definitions and descriptions supplied by selected writers. This selection of writers was made from works in epistemology, logic and education (e.g., Dewey, Nagel, and Kerlinger) that most thoroughly explained "hypothesis" and "hypothesizing." A work done by W. W. Charters, Jr., at the University of Oregon entitled, <u>The Hypothesis in Scientific Research</u>, provided the focus for this phase of the investigation, constituting Chapter 2.

From this material was derived a systematic schema respecting the major identifying components and characteristics of the "ideal" hypothesis. The necessary criteria and constituent components were then outlined and numbered for use in the subsequent analysis.

The next major step, reported in Chapter 3, involved the analysis of relevant material in "methods" books, journal articles, compilations, and so on, that deal with the use of the hypothesis in the so-called discovery, problem-solving, or inquiry approaches in social studies. A sample of contributions produced in North America from 1960 to the present were analyzed.

This analysis was meant to determine the validity and comprehensiveness of each of the formulations concerning hypothesis and the process of hypothesizing. "Validity" and "comprehensiveness" were based on the set of standards previously established. Thus, with subjective interpretation being somewhat necessary, the writers were judged entirely by the produced schema. This evaluation, while attempting to measure both "quality" and "quantity," or depth as well as breadth, of coverage, employed largely quantitative methods. Statements of, or references to, individual schema points, were pinpointed, totaled, and compared.

From this survey, then, the more obvious strengths and weaknesses of the various social studies "methods" people in their use of the concept, hypothesis, were identified. As well, a general assessment of "coverage" of the concept was made.

In the final chapter conclusions were arrived at and implications for dealing with the state of "hypothesis" theory in social studies specifically, and all inquiry generally, were discussed. As well, recommendations for proceeding to meet any requirements evidenced by the findings, as well as recommendations for further studies, were made.

Chapter 2

THE SCIENTIFIC HYPOTHESIS

INTRODUCTION

The objective of this chapter is to develop, for purposes of the proposed analysis of social studies writers in Chapter 3, a conceptual schema for hypothesis. To do so requires the setting out of an outline of what constitutes, and contributes to, a "good" hypothesis.

Arriving at such a schema involves an in-depth analysis of the concept. Such an analysis is particularly necessary for gaining a workable understanding of the concept, hypothesis, and of how to hypothesize.

Hypothesis, in accordance with Dewey's classification, may be analyzed from three main perspectives: namely, _function_, _origin_ and _structure_.[1] Dewey states the need for considering each of these components while recognizing their functional relatedness:

> It will be found that psychological inquiry into the origin of the hypothesis is not irrelevant in respect to an understanding of its structure and function; for origin and function cannot be understood apart from each other, and, since structure must be adapted to function, it cannot be independent of origin. In fact, origin, structure, and function are organically connected, and each loses its meaning when absolutely separated from each other.[2]

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[1]John Dewey, _Studies in Logical Theory_ (Chicago: University of Chicago Press, 1903), p. 145.

[2]_Ibid_.

Figure 1 may aid visualization of the organic association of the three components.

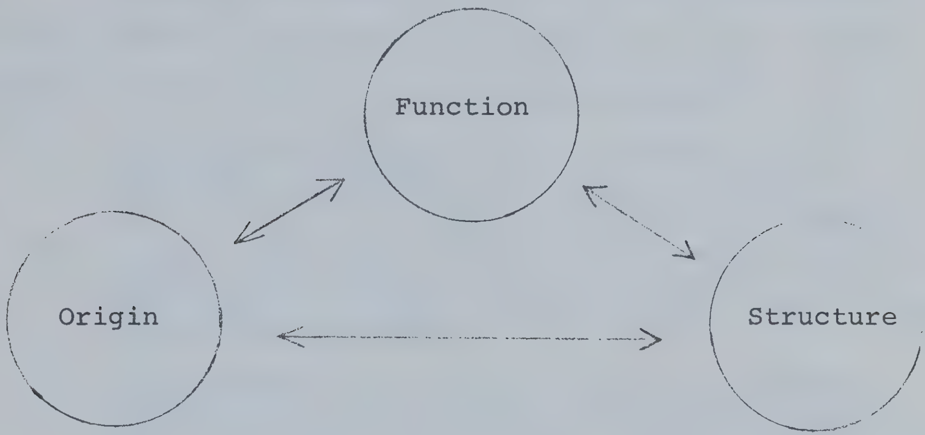

Figure 1 - Dewey's Perspectivism in the Analysis of the Concept, Hypothesis

The analysis to follow is carried out according to this categorization and perspective.

This chapter consists of the following. For the purpose of producing a general, preliminary description selected definitions of the concept, hypothesis, are listed and analyzed. Then, in the major portion of the chapter, discussions of hypothesis by selected writers are analyzed and organized around Charters' "schema." Even though Charters' outline, as one of the more comprehensive works, serves as the focus, where necessary, elaboration and supplementation are considerable. Both this primary analysis and the preliminary one, are subdivided corresponding with Dewey's three components: function, origin, and structure. Finally, a point-form summary of the schema derived from the

two analyses is made.

DEFINITION ANALYSIS

To produce a general idea of what a hypothesis entails, and to contribute to the basis for the planned schema, the following definitions are offered.

1. . . . an unsupported or ill-supported theory; a supposition advanced with little to warrant it; a mere guess or conjecture (Standard Dictionary).
2. . . . a statement of what is deemed possibly true, assumed and reasoned upon as if certainly true, with a view of reaching truth not yet surely known (Standard Dictionary).
3. [Hypotheses] . . . are the results of regular reflection on experiences, and, as premises in tentative deduction, form the necessary preliminaries to adequate knowledge (Standard Dictionary).
4. . . . a statement of fact or of theory which, without itself having been proved, is taken for granted as a premise from which to discover an assured conclusion; a logical supposition; more widely, a suppositious or imaginary state of things assumed as a basis or reasoning. . . (Standard Dictionary).[3]
5. . . . a proposition, condition, or principle which is assumed, perhaps without belief, in order to draw out its logical consequences and by this method to test its accord with facts which are known or may be determined (Webster Dictionary).
6. A tentative theory or supposition provisionally adopted to explain certain facts and to guide in the investigation of others . . . (Webster Dictionary).
7. . . . something assumed or conceded merely for the purposes of argument or action . . . (Webster Dictionary).[4]

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[3]Isaac K. Funk, and others (eds.), Standard Dictionary (New York: Funk & Wagnalls, 1963).

[4]William A. Nielson (ed.), Webster Dictionary (Springfield, Mass.: G & C. Merriam Company, 1964).

8. . . . a provisional or working explanation of phenomena faithfully observed and recorded, and it must be discarded when further observations prove it to be untenable.[5]

9. . . . a suggested answer, or educated guess based on the facts in the original situation out of which the problem arose.[6]

10. . . . a tentative and provisional thesis put forward upon the basis of accumulated knowledge for the guidance of further investigation and research.[7]

11. . . . a name that may be applied to any conception by which the mind establishes relations between data of testimony, of perception, or of sense, so long as that conception is one among alternative possibilities, and is not referred to reality as fact.[8]

12. . . . a conjecture which specifies the natural agents taken to be at work in a phenomenon and to be the means of fulfilling the postulate involved in it, in the case under investigation.[9]

13. . . . a supposition regarding the cause of a phenomenon, which we make either as a preliminary to an experiment which will prove or disprove the supposition, or in lieu of an experiment or systematic observation, when such are impossible owing to the peculiar conditions of the phenomenon itself.[10]

14. . . . a method of explanation. . . .[11]

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[5]Sir Richard Gregory Arman, Discovery; or, The Spirit and Service of Science (London: Macmillan, 1916), p. 161.

[6]William Henry Burton, Education for Effective Thinking; an Introductory Text (New York: Appleton, 1960), p. 64.

[7]Herbert Leon Searles, Logic and Scientific Methods, An Introductory Course (New York: Ronald Press, 1956), p. 231.

[8]Bernard Bosanquet, Logic or the Morphology of Knowledge (Oxford: Clarendon Press, 1911), p. 151.

[9]Ibid., p. 152.

[10]John Grier Hibben, Logic, Deductive and Inductive (New York: Charles Scribner's Sons, 1923), p. 291.

[11]Ibid., p. 292.

15. . . . a supposition that is necessary to construct facts into a system. . . .[12]

16. . . . a conjecture which seeks to fill up the postulate thus abstractly stated by specifying the concrete causes, forces, or processes out of which the phenomenon really arose in this particular case, while in other cases maybe the same postulate is to be satisfied by utterly different though equivalent combinations of forces or active elements.[13]

17. . . . a conjectural statement of the relation between two or more variables.[14]

18. . . . any tentative supposition by the aid of which we endeavor to explain facts by discovering their orderliness.[15]

19. [Hypotheses are] . . . conjectural statements of the relations among variables; . . . are thus the critical intermediaries between research questions . . . and behavioral observations.[16]

These definitions vary considerably in type, generality and comprehensiveness. Nevertheless, they can be reduced to two main categories: unsystematic or non-scientific, and systematic or scientific.

The systematic type, employed in discussions of higher thinking processes, is more demanding in the sense of necessitating definite guidelines respecting the components of function, origin, and structure. The unsystematic type is, in contrast, often used rather loosely, seemingly

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[12] Ibid., p. 293.

[13] Ibid., p. 303, citing Lotze, Logic, pp. 349-50.

[14] Fred Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart, and Winston, 1964), p. 20.

[15] A. Wolf, Textbook of Logic (London: George Allen & Unwin Ltd., 1930), p. 155.

[16] Fred Kerlinger, "Research in Education," Encyclopedia of Educational Research, ed., Robert L. Ebel (4th ed., New York: Macmillan Company, 1969), p. 1129.

restricted in its scope by very few qualifications.

Examples from the definitions quoted of the description of the unsystematic variety can be identified: "an unsupported or ill-supported theory"; "a supposition advanced with little to warrant it"; "a mere guess or conjecture"; "more widely, a suppositious or imaginary state of things assumed as a basis of reasoning"; and, "something assumed or conceded merely for the purposes of argument or action." Very few requirements or criteria are considered necessary in the use of this type of hypothesis; thus its definition is most broad, and its use highly generalized.

The present study is not concerned with this category of hypothesis except where, in its use, claim is made, explicitly or implicitly, to "scientific" status. Only then is its use assessed on the basis of the schema for the scientific hypothesis. It is only the scientific or systematic hypothesis, which because of its structural requirements, lends itself to schematic organization.

The foregoing definitions are analyzed largely by locating elements relating to the three components of function, origin, and structure. The basic purpose of these summary extractions is to construct a synthesis of descriptions that would serve as part of the foundation for the schema to be developed.

Preceding this breakdown, however, is a listing from the definitions of key terms and phrases, particularly synonyms, that provide an initial, general indication of what

an hypothesis is.

General Description

Synonyms of hypothesis or explanatory phrases in the foregoing definitions include the following: "theory"; "supposition"; "guess"; "conjecture"; "educated guess"; "statement of what is deemed possibly true"; "premises in tentative deductions"; "statement of fact not proved"; "logical supposition"; "a suppositious or imaginary state of things"; "assumed condition"; "assumed principle"; "tentative theory"; "provisional explanation"; "working explanation"; "suggested answer"; "tentative thesis"; "provisional thesis"; "conjectural statements"; "tentative supposition"; "alternative possibility"; "method of explanation"; and "supposition regarding the cause of a phenomenon."

To produce a synthesis of these descriptions, the list is summarized according to the categorization deemed most reflective of the various phrases:

1. form: theory; thesis; premise; supposition; conjecture; guess; unproven statement; assumed principle; working explanation.
2. status; possibly true; tentative; unproven; logical; imaginary; assumed; provisional; alternative; working.

Components

A. Function. Function of a hypothesis which can be described by reference to its purpose or method of use is

revealed in the following phrases: "reasoned upon as if certainly true, with a view of reaching truth"; "as premises in tentative deductions"; "as a premise from which to test or discover an assured conclusion"; "basis of reasoning"; "form the necessary preliminaries to adequate knowledge"; "assumed in order to draw out its logical consequences to test its accord with facts"; "provisionally adopted to explain certain facts and to guide in the investigation of others"; "merely for the purposes of argument or action"; "for the guidance of further investigation and research"; "statement of the relation between two or more variables"; "endeavor to explain facts by discovering their orderliness"; "establishes relations between data of testimony, of perception or of sense"; "specifies the natural agents taken to be at work in a phenomenon and to be the means of fulfilling the postulate involved in it"; "necessary to construct facts into a system"; "seeks to fill up the postulate thus abstractly stated by specifying the concrete causes, forces, or processes out of which the phenomenon really arose in this particular case"; "[deals with] the relation between two or more variables"; and, "the critical intermediaries between general research questions and behavioral observations."

From this list major functions can be identified:

1. expresses the relation between two or more variables,
2. guides investigation and research,
3. explains certain facts; tests or discovers an assured conclusion; provides a necessary avenue to knowledge;

facilitates the reaching of truth.

4. discovers the orderliness of facts; establishes relations between data; constructs facts into a system (closely associated with 3).

5. draws out its own consequences to test its accord with facts; provides a premise for deductions; provides a basis for reasoning (also closely associated with 3).

6. specifies natural agents taken to be at work in a phenomenon; specifies concrete causes, forces or processes.

7. fills up the more abstract postulate [or theory].

8. provides an intermediary between general research questions [based on theory] and behavioral observations (really, the linking of 6 and 7 to produce 3).

B. Origin. Origin is dealt with in the definitions by these phrases: "unsupported or ill-supported"; "little to warrant it"; "the results of regular reflection on experiences"; "assumed, perhaps without belief"; "based on the facts in the original situation out of which the problem arose"; "[based on] accumulated knowledge"; "[based on] phenomena faithfully observed and recorded"; "[based on] a postulate, a more general hypothesis, which must be related to the specific, concrete 'revelation,' and is thus conditional upon that particular situation"; "[based on] general research questions and behavioral observations."

A synthesis of principles for origin, subdivided into appropriate categories is then derived:

1. reflection on experiences; facts in the original situation out of which the problem arose; phenomena faithfully observed and recorded; data of testimony; perception or sense; characteristics of concrete situations; behavioral observations.
2. accumulated knowledge; a postulate; a more general hypothesis [theory]; general research question.

C. Structure. The following extracts allude to the structure component: "a statement of fact or of theory"; "specifies the natural agents taken to be at work in a phenomenon"; "specifying the concrete causes, forces, or processes out of which the phenomenon really arose in this particular case"; "statement of the relation between two or more variables"; and "statements of the relations among variables." The requirements of structure are relatively clearcut and definitive. Apart from the fact that a hypothesis is a "statement of fact or theory" dealing with "natural agents," in concentrating on structure in its purely analytic sense, it can be said that a hypothesis must consist of at least two variables. These variables must be in some relation to each other. That is, a hypothesis must take the form, "if 'X,' then 'Y'"--where either or both variables may be plural and relate or correlate with one another in varying ways and degrees. A simple way of indicating this relationship is to say that "X" is a function of "Y." This aspect of structure will be explained more fully

in the next section

A general description of what a hypothesis involves has been developed from an analysis of the selected definitions. The formulations respecting function, origin, and structure are used in the construction of the final schema.

MAJOR ANALYSIS

Step two in the construction of a schema for hypothesis centers around Charters' main ideas as he pinpoints some of the major facets of the three components, function, origin, and structure. Charters does not categorize his analysis according to Dewey's classification; yet his description fits very conveniently into the categories of function, origin, and structure. Charters' work on analysis of hypothesis has been chosen because of its inclusiveness and clarity of statement. Ideas of others are used to supplement and elaborate on the points outlined in Charters' paper.

Function

Of the three components, function is the most crucial. It receives by far the most extensive coverage by writers in the fields of logic and thinking. Function connotes purpose, and thus concerns the significant question, "What is an hypothesis for?" Of course function more directly deals with the question, "What does an hypothesis do?" As well, of the "organic" relationship amongst the

three components, it can be said that function has the most direct influence of the three upon one another. This follows from the fact that it is the pre-eminent component. Dewey, again discussing the inter-relatedness of the three components, indicates this pre-eminence:

> The function of the hypothesis is to unify, to furnish a method of dealing with things, and its structure must be suitable to this end. It must be so formed that it will be likely to prove valid, and writers have formulated various rules to be followed in the formulation of hypotheses.[17]

Characteristics of, or criteria for, a "good" hypothesis are included in this section. Characteristics of an hypothesis are considered closely associated to functions of an hypothesis. Function stipulates, if only by implication, just which characteristics or criteria will be conducive to its fulfillment. For example, one function of an hypothesis is to predict. Hence, one characteristic of a "good" hypothesis will be predictability. This relationship is, however, not always as evident. Some desired characteristics such as simplicity do not directly imply particular functions, but generally foster the attainment of many or all functions.

Constituting the first function to be discussed, one of Charters' points dealing with features of an hypothesis serves to initiate this phase of the study of hypothesis.

Connecting link. "The hypothesis is the connecting link between two worlds: the world of explanation and theory and the empirical world of phenomena and fact. The purpose

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[17] Dewey, Studies in Logical Theory, op. cit., p. 143.

of scientific research is to correct explanations or theories and the function of the hypothesis is to guide such research."[18]

Implicit in this function is the notion that a logical sequence of reasoning governs the formulation and implementation of the hypothesis. The hypothesis is derived directly, or indirectly by deduction, from theory, carrying this theory to the empirical domain to "face" the evidence. Searles declares that hypotheses, ". . . must be consistent with the presuppositions, postulates, principles, and already verified facts in the field of investigation."[19] Kerlinger states that hypotheses, ". . . are the working instruments of theory, [and] . . . can be deduced from theory and from other hypotheses."[20]

As stated, the hypothesis must connect theory with fact. In reference to the need to relate to the "empirical world of phenomena" Cohen and Nagel affirm that, "it is the task of inquiry to determine which of the possible explanations or solutions of the problem is in best agreement with the facts. Formal considerations, they claim, are, therefore, never sufficient to establish the material truth of any theory.[21]

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[18]William W. Charters, Jr., "The Hypothesis in Scientific Research" (unpublished paper, Oregon: University of Oregon, 1967), p. 2.

[19]Searles, op. cit., p. 189.

[20]Kerlinger, "Research in Education," op. cit., p. 22.

[21]Morris R. Cohen and Ernest Nagel, An Introduction to Logic and Scientific Method (New York: Harcourt, Brace, and Company, 1934), p. 393.

Both Hibben[22] and Wolf[23] assert that a hypothesis must be both based in, and validated by, concrete evidence, specifying exact conditions.

Kerlinger supplies a very succinct explanation of the linking function, at the same time indicating its real purpose. He attests that "problems and hypotheses advance scientific knowledge by helping the investigator to confirm or disconfirm theory."[24] How is this done? "Hypotheses incorporate the theory, or part of it, in testable or near-testable form."[25] He thus concludes that, "Hypotheses . . . are important bridges between theory and empirical inquiry."[26]

The scientific process is both logical and empirical. The hypothesis, being essential to scientific inquiry, must, therefore, meet the requirements of logic; it must be logical in form of derivation or formulation as well as in its functioning within the over-all process. Kaplan refers to the need for a hypothesis in stating, "To be sure, logic is interested in the greatest possible range of application of its norms and in the firmest possible grounding of their

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[22]Hibben, op. cit., p. 303, citing Lotze, Logic, pp. 349-50.

[23]Wolf, op. cit., p. 30.

[24]Kerlinger, op. cit., p. 23.

[25]Ibid., p. 24.

[26]Ibid.

claims."[27] By "norms" is meant theory, and by "firm grounding" is meant basis in the empirical world of phenomena and fact. The hypothesis is needed to transcend, by logical means, the "gap" between these realms.

To perform this function of "bridging" by empirical testing the hypothesis must yield to logical reduction or deduction, always maintaining a logical connection with the theory that gave it birth. Dewey makes this point in his summation of the hypothesizing process:

> An hypothesis once suggested and entertained, is developed in relation to other conceptual structures . . . [theory, explanation, other forms of the hypothesis, etc.] . . . until it receives a form in which it can investigate and direct an experiment that will disclose precisely those conditions which have the maximum possible force in determining whether the hypothesis should be accepted or rejected.[28]

If this deduction is not carried out a problem of application may result. Cohen and Nagel discuss this difficulty:

> Hypotheses are required at every stage of an inquiry. It must not be forgotten that what are called general principles or laws (which may have been confirmed in a previous inquiry) can be applied to a present, still undetermined inquiry only with some risk. For they may not, in fact, be applicable.[29]

This talk of reduction in form and Cohen and Nagel's consideration of "general laws of any science functioning as

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[27]Abraham Kaplan, The Conduct of Inquiry--Methodology for Behavioral Science (San Francisco: Chandler Publishing Company, 1964), p. 18.

[28]John Dewey, Logic--The Theory of Inquiry (New York: Holt, Rinehart, and Winston, 1938), p. 112.

[29]Cohen and Nagel, op. cit., p. 393.

hypotheses"[30] seem to imply the existence of more than one "level" of hypothesis. Considering the claim made by Dewey and others that there is basically only one type of scientific hypothesis regulated by one set of rules or necessary criteria, is this possible? Actually, no contradiction exists. That is, there do exist various "levels," but only one basic "type." As long as apparently differing types (with the exception of the systematic--unsystematic dichotomization) are considered to vary only according to position on a continuum of generality or abstractness, all "versions" (e.g., working hypothesis, testing hypothesis, etc.) can be classified as one in structure, general function, and traceable origin. Of course, this standardization can only be considered reasonable if logical "transformation" (deduction, induction, generalization, synthesis, analysis, etc.) is encompassed by this conception.

That the scientific hypothesis does vary in the fashion just indicated is most clearly expressed by Charters himself:

> . . . assertions and statements about the world of reality (including hypotheses, explanations, theories and the like) array themselves along a continuum of abstraction or generality. It is something of a matter of indifference what labels one attaches to assertions at the various levels. What is important is to recognize that assertions differ in degree of abstraction and to understand what problems of logical inference are involved as one moves from one level to another.[31]

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[30] Ibid.

[31] Charters, op. cit., p. 3.

Stephens alludes to the same principle of gradation on an abstractness-concreteness continuum where he states that,

> The higher reaches of science--statements on a high level of generality, high-level laws and theories --are generally inferred-variable hypotheses. Theory in the physical sciences can be pictured as a sort of abstraction pyramid. At the pyramid's base are observed -variable hypotheses, directly tested, the so-called "fact-like statements" and "experimental laws." These are explained, brought together, at a higher level of abstraction by more general statements. These in turn are explained by still higher-level theories which are explained by still more high-level theory.[32]

By diagraming Stephen's description in the form of an actual pyramid, it is considered possible to construct a technique for classifying various explanations and so-called "types" of hypotheses. The pyramid described by Stephens is shown in Figure 2. Classifications listed by him are shown on the left-hand side with the right-hand side being reserved for the arbitrary placement of other categories or concepts encountered in the present analysis.

It should be stressed in connection with both Charters' and Stephens' explications that the classification of any particular statement is entirely relative to the status accorded it in the inquiry or logical process concerned. Thus, a general law for one line of reasoning may serve only as a "working hypothesis" in another. Medawar posits this very principle in stating that,

> hypotheses and axioms may be shared between cognate theories, and the logical consequences of one theory

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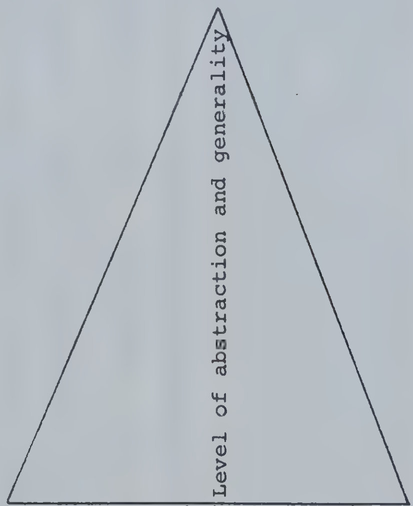
[32]William N. Stephens, <u>Hypotheses and Evidence</u> (New York: Thomas Y. Crowell Company, 1968), p. 117.

Theory, Laws, Explanations,

Postulates, Axioms



Facts, empirical evidence

[Foundation]

Stephen's Classification	Investigator's Classification
Highest level theories	Transcendent hypotheses
High level theories	Composite hypotheses
General statements	Conceptual hypotheses
Experimental laws	Explanatory hypotheses--Test hypotheses
Fact-like statements	Working hypotheses
Observed-variable hypotheses	Operational hypotheses
	Hypotheses about observed things only

Figure 2 - Hypothesis Classification According to Stephens' Abstraction Pyramid.

may represent the starting point--the hypotheses or assumptions--of a theory of lower level.[33]

Hibben endorses the idea of a broad spectrum incorporating many hypotheses:

> But between these most general presuppositions, upon which all induction is grounded, and the simplest cases to which they can be applied, there is a wide region within which the hypotheses which are always necessary for induction can only be formed tentatively. . . .[34]

Barker in discussing confirmation theory indicates the need for a uniform "hypothesis theory" (implying that variance would be attributed solely to degree of abstraction):

> We do not want a theory of confirmation that will apply only to universal hypotheses, or only to particular hypotheses, or only to hypotheses of any other such limited form. We want a theory which will be able to account for whatever degree of confirmation hypotheses of any truth functional or quantificational form may come to possess.[35]

Barker also talks of transcendent hypotheses which concern unobserved things. He points out that these cannot be confirmed through inductive reasoning (presumable "upwards" to ratification by more general theory). This position concurs with the requirement of confirming solely by empirical testing, whether directly, or indirectly requiring deduction. Barker, therefore, adopts the reductionist view:

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[33]Sir Peter Brian Medawar, Induction and Intuition in Scientific Thought, (Philadelphia: Memoirs of the American Philosophical Society, 1969), p. 46.

[34]Hibben, op. cit., p. 313.

[35]Stephen Francis Barker, Induction and Hypothesis; A Study of the Logic of Confirmation (Ithaca, N. Y.: Cornell University Press, 1957), p. 28.

". . . transcendent hypotheses, although they are genuine statements, are not to be taken literally, but are to be construed as shorthand for clumsier hypotheses about observed things only."[36] The point to be made is that these hypotheses, as well, can be categorized by abstraction distance from the empirical "manifestations."

The concept of "working hypotheses" can also be placed on the continuum, probably close to the base of the pyramid. Its status is appropriately relegated by Bosanquet's definition:

> A "working hypothesis"--and most of the great unifying conceptions of modern science are working hypotheses--is the suggestion of a real [italics not in the original] agent taken as equivalent to the suggestion of a mere law of principle.[37]

In Bosanquet's explanation of the formulation of such a hypothesis can better be seen its relationship with general and abstract theory:

> The Postulate sets an abstract problem which hypothesis has to solve in the concrete. . . . When the hypothesis is moulded into the postulate, not or not exclusively by proof of the concrete supposition, but in a great degree by attenuating its content into a "law of action," then we have a "working hypothesis," i.e., materially an abstract postulate, but formally a supposition of a real agent.[38]

Charters, as well, classifies hypothesis category according to abstractness and generality. He recognizes two "types," neither of which can really be considered to parallel

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[36]Ibid., pp. 95-96.

[37]Bosanquet, loc. cit.

[38]Ibid., p. 152.

any other here considered, but do tie in with Stephen's system. They are the conceptual hypothesis and the operational hypothesis. Charters explains their status and purpose:

> The conceptual hypothesis is the more general of the two. It translates a rather abstract explanation or proposition into testable form. Normally, however, the conceptual hypothesis is still too general to describe exactly [italics in the original] what the researcher expects to observe in the extremely particular circumstances where he makes his observations. The investigator then is faced with the task of restating the conceptual hypothesis as concretely as he can--in terms of the particular operations, observations, measures, and conditions in which the empirical research is carried out. This very concrete prediction is the operational hypothesis.[39]

Although the specific purpose of a hypothesis does not stipulate what structure or "physical nature" it can have--since this feature is standard for all hypotheses used in investigation--it does determine choice of hypothesis type from the "abstractness scale." Thus Ruby distinguishes two types of hypotheses according to purpose:

> There are two kinds of hypotheses: the preliminary, provisional guesses which tell us what to look for in the beginning of an investigation (the "working hypotheses" which delimit the relevant facts); and the major explanatory hypotheses or theory which is put forth as a solution of the problem [italics not in the original].[40]

It should be made clear that, in spite of the variance in purpose, both types of hypothesis do relate to the major functions of the concept: that is, explanation, problem solution, direction of investigation, etc. This

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[39] Charters, op. cit., p. 4.

[40] Lionel Ruby, The Art of Making Sense; A Guide to Logical Thinking (Philadelphia: Lippincott, 1968), p. 253.

relation is more direct or less direct depending on the level of generality determined by the specific purpose at hand.

It is to be noted, as well, that there does seem to exist some discrepancy between Bosanquet's "working hypothesis" and Ruby's "working hypothesis." They are evidently used for different purposes; and hence function somewhat differently. Regardless, as discussed, method of use will decide the type of concept--whatever name assigned to it--to be employed.

Kaplan makes a distinction very similar to that of Ruby's. Where Ruby considers an explanatory hypothesis, however, Kaplan refers to a test hypothesis. The difference seems negligible. Kaplan writes:

> To carry forward an inquiry we may formulate working hypotheses. These serve to guide and organize the investigation, providing us something to go with. The working hypothesis is not a guess at the riddle, a hunch as to what the answer might be. It is an idea, not about the outcome of inquiry but about the next steps that may be worth taking. The working hypothesis formulates a belief pertaining to the course of inquiry but not necessarily pertaining to its ultimate destination.
>
> After the inquiry is well under way a conjecture or surmise may emerge as to the solution of the problem. We call it the test hypothesis. This is what we think may well be the truth of the matter and we then organize the inquiry so as to facilitate the decision on whether the conjecture is correct.[41]

To ask whether one type of hypothesis is more important to inquiry than another type is a moot question,

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[41]Kaplan, op. cit., p. 88.

since they can be assessed only in regards to the specific purpose. All may be instrumental, and thus necessary, to an investigation. In spite of this fact it is true that the more general or encompassing the hypothesis (i.e., "higher" its location in the pyramid), the more powerful it will be in achieving certain of an hypothesis' primary functions, namely explanation, prediction and problem solution. This type will be less limited in significance and extent of application. Salmon makes this point concerning hypotheses of varying scope:

> The unification of restricted hypotheses by means of more comprehensive hypotheses leads to the possibility of hypotheses which can be confirmed by vast amounts and varieties of evidence. Such hypotheses are rich in predictive and explanatory power.[42]

It should be noted that according to Salmon the more general hypothesis actually incorporates "lesser" hypotheses. Bourne also talks of a "composite" hypothesis embodying "sub-hypotheses."[43]

The value of the broad hypothesis may be discovered in more than just its greater predictive power. Because it approaches more closely the realm of more general explanations, laws, and theories, and is consequently more encompassing than a "lower order" hypothesis, it fulfills a more decisive role in the bridging of theory and facts.

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[42] Wesley C. Salmon, Logic (Englewood Cliffs, N. J.: Prentice-Hall, 1963), p. 88.

[43] Lyle Eugene Bourne, Human Conceptual Behavior (Boston: Allyn and Bacon, 1966), p. 38.

Of course, it must be granted that the broad hypothesis can be used only indirectly for empirical confirmation. Any hypothesis, to directly yield a solution, explanation, law, or theory, must indicate just how data collection and testing will proceed. To so indicate specification is necessary; a general hypothesis would not do. Only the more "concretely" worded hypothesis can bear immediate fruit in the form of empirical evidence--the foundation of any theory. It is the development of this more specific hypothesis that culminates in what Dewey calls "the special 'if-then' proposition that directs experimental observations yielding new data."[44]

At first glance Salmon's and Dewey's conceptions of "powerfully" useful hypotheses may appear incompatible. Actually both the general and abstract, and the concrete and specific, hypothesis is very necessary in all scientific inquiry. Returning to the logical character of hypotheses it must be understood that the hypothesis is the product of either induction or deduction.. In spite of the earlier emphasis on deduction, it must be acknowledged that forming an hypothesis can be largely an inductive process, whereby relevant data and knowledge from past experience are analyzed. Actually in scientific research this formulation should be closely guided by established laws and theory (deduction) and the actual facts bearing on the case (induction). Thus there

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[44]Dewey, Logic, op. cit., p. 427.

must be a constant shuffling between the two logical processes: constant inducing from initial observations in striving to reach "theoretical validation" and constant deducing to insure the capacity to test in the empirical world. This interlocking process explains, in fact, how the hypothesis, in any form, or at any "level," is able to perform the necessary function of linking the "world of explanation and theory" with the "empirical world of phenomena and fact," the express purpose being to extend the domain of the former.

Guide. In the latter part of the previous function or rule stated by Charters can be identified another essential function, which could be considered necessary (but not sufficient) to achieve the first. He states, "The purpose of scientific research is to correct explanations or theories and the function of the hypothesis is to guide such research [italics not in the original].[45]

Charters elaborates on this by saying of the hypothesis that, ". . . it helps to specify what is to be measured--what data must be collected,"[46] and also that "it governs the process and direction of data analysis."[47]

Dewey stresses that a hypothesis receive:

> . . . a form in which it can investigate and direct an experiment that will disclose precisely those conditions which have the maximum possible force

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[45] Charters, op. cit., p. 2.

[46] Ibid., p. 17.

[47] Ibid.

> in determining whether the hypothesis should be accepted or rejected [italics not in the original].[48]

Thus, to a great extent the hypothesis guides research, determining what conditions and data are relevant to the investigation, by means of its own empirical testing. Cohen and Nagel in explaining that hypotheses are required at every stage of inquiry define another more general mode by which hypotheses guide research. They state that "the general laws of any science function as hypotheses, which guide the inquiry in all its phases."[49]

This type of "guiding" seems to involve more the setting of general limitations or boundaries on the area of investigation than the stipulation of specific data or modes of analysis to be chosen. This idea is probably closer to what Charters termed "governing the _direction_ of data analysis." Dewey is probably including both conceptions when he considers hypothesis "a method of organization and control."[50]

Apart from this distinction, it should be emphasized that a hypothesis directs an investigation in two associated ways: (1) As mentioned, it determines what data are relevant to satisfying the conditions of the hypothesis, once formulated, and (2) in the process of formulation it also organizes thought produced by previous experience, synthesizing

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[48] Dewey, _Logic_, _op. cit._, p. 112.

[49] Cohen and Nagel, _op. cit._, p. 393.

[50] Dewey, _Studies in Logical Theory_, _op. cit._, p. 183.

contributing empirical evidence and the bearing of related laws and theory. That is, by providing what at the time is considered a feasible solution or explanation, the hypothesis "funnels" relevant knowledge and "zeros" in on the specific formulation of the problem. Thus, the very creation or construction of a hypothesis requires a focusing of past knowledge, already guiding the purpose and direction of the investigation, even prior to the search for significant data.

Searles perhaps even exaggerates this aspect when he claims that:

> . . . since the main purpose of an hypothesis is to explain, bring into _order_, and _summarize_ a body of facts in the form of a possible law, the first criterion of a good hypothesis is that it be capable of accomplishing this purpose [italics not in the original].[51]

It is true that there exists little functional difference between the two aspects, the hypothesis being both based on and tested by the available facts. Yet the organizing, directional function can be considered as influencing two phases, indicated by Charters: a hypothesis decides "what must be collected." The "double function" is described by Gregory in the following way:

> . . . given the results of observation or experiment, the philosopher endeavors to discover a law or principle connecting them. He guesses at their meaning, and invents a hypothesis which may, or may not, be confirmed by future investigations.[52]

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[51] Searles, _op. cit_., p. 237.

[52] Arman, _loc. cit_.

Even though, as stated, the directive and integrative function of a hypothesis essentially has but one purpose, the emphasis is normally placed on its role as a "regulator" of investigation subsequent to formulation, providing the means to select pertinent information, evidence, or facts. Dewey expresses this function as follows:

> The real problem is: What facts are evidence in this case? The search for evidential facts is best conducted when some suggested possible meaning is used as a guide in exploring facts, especially in instituting a hunt for some fact that would point conclusively to some explanation and exclude all others. So the person entertains various hypotheses.[53]

Burton discusses this particular need:

> A problem well stated--now what is the answer? The naive thinker almost always at this point suggests, "We must get the facts." Yes, but what facts and where do we look? Just to gather facts, as some researchers do, is nothing but busy work . . .,[54]

and then answers his own question, while providing the application for education:

> A number of hypotheses, as stated, are necessary to initiate and guide observation in the search for facts. Many naive teachers and parents say we must train children in "the powers of observation." There are no such powers which can be trained independently. Everyone can observe, but he must have a direction in which to observe. Darwin long ago said: "How odd it is that anyone should not see that all observation must be for or against some view, if it is to be of any service."[55]

The directional and organizational power of hypotheses is

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[53]John Dewey, How We Think (Boston: Heath, 1933), p. 168.

[54]Burton, op. cit., p. 62.

[55]Ibid.

clearly enunciated by Wolf: "Without the guidance of hypotheses we should not know what to observe, what to look for, or what experiments to make, in order to discover order in nature . . .,[56] and by Hibben: ". . . in order to give some definite direction to investigation, to serve in our analysis of phenomena into their elements as a means of breaking up complete phenomena on certain lines. . . ."[57]

The hypothesis does more than just decide _which_ data are to be observed and incorporated. The hypothesis demands the assimilation of _associated_ data. The data must have some ordered relation to both one another and the central subject of inquiry. Why is this so? They must, for one thing, produce an integrated source of information for assessing the postulated solution or explanation. Secondly, efficiency and coherence in solving problems, in dissolving the discrepency between what is known and what is not known, requires systematization through some means of classification. Since the hypothesis is employed for this very purpose, providing the means, it is the hypothesis that assimilates and organizes data. Cohen and Nagel speak of this particular role:

> The function of a hypothesis is to direct our search for the order among facts. . . . Facts must be selected for study on the basis of a hypothesis. In directing an inquiry, a hypothesis must of

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[56] Wolf, _loc. cit_.

[57] Hibben, _loc. cit_.

> necessity regard some facts as significant and others as not . . .,[58]

and, ". . . a hypothesis is believed to be relevant to a problem if it expresses determinate modes of connections between a set of facts, including the fact investigated. . . .[59]

Hibben stresses this function as well where, in reference to the need for a hypothesis as a method of explanation, he says:

> We are not always able to perceive the relations existing between facts as they come into the sphere of our experience, and yet we are constrained to think of them as related. . . . This supposition that is necessary to construct facts into a system is a hypothesis.[60]

Evidently, then, the main basis or criterion for determining "relevance" of facts or data--and, hence, an hypothesis' ability to perform this function--is their own inter-relatedness, and relatedness to the problem and suggested solution at hand. This Dewey puts very succinctly (and, as well, alludes to the double function earlier mentioned) when he says that:

> . . . the criterion for the validity of such hypotheses is the capacity of the new data they produce to combine with earlier data (describing the problem) so that they institute a whole of unified existence . . .,[61]

and that, ". . . the hypothesis . . . must be such as

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[58]Cohen and Nagel, op. cit., p. 201.

[59]Ibid., p. 202.

[60]Hibben, op. cit., p. 292.

[61]Dewey, Logic, op. cit., p. 427.

operationally to provide the new data that fill out and order those previously obtained."[62]

To sum up this primary directing and organizing function of a hypothesis from a more general frame of reference Dewey is again quoted:

> . . . it is generally admitted that the function of the "H" is to provide a way of dealing with the data or subject-matter which we need to organize. . . . We then recognize the hypothesis to be . . . a method of organization and control.[63]

Perhaps the real significance of this function can be best indicated by noting the importance of its place in the process of inquiry. Dewey says that:

> . . . the data which are commonly taken as the given material are not something to which the hypothesis is subsequently applied, but that, instead of this external relation between data and hypotheses, the hypothesis exercises a directive function in determining what are the data. . . . Data are selected in order to be determined, and hypotheses are the ways in which this determination is carried on.[64]

The hypothesis serves as a means of selection, and in so doing it organizes and makes sense out of necessary information.

Prediction. Another critical function of a hypothesis is prediction. Charters states:

> A hypothesis is a prediction. It is a sentence that states explicitly what can be expected to happen under

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[62]Ibid.

[63]Dewey, Studies in Logical Theory, op. cit., p. 183.

[64]Ibid., p. 145.

> specified conditions. It says, if a person does X (or if X occurs), then Y can be expected to ensue.[65]

Kuslan talks of this function.[66] Kerlinger makes a statement practically identical to Charters: ". . . a hypothesis is a prediction. It says that if "X" occurs, "Y" will also occur."[67] Of prediction Cohen and Nagel have this to say, "A hypothesis becomes verified, but of course not proved beyond every doubt, through the successful predictions it makes."[68] Here the main purpose of this function is given: it permits testing which allows either confirmation or confutation. Cohen and Nagel elaborate, "The logical function of prediction is to permit a genuine verification of our hypothesis by indicating, prior to the actual process of verification, instances which may verify them."[69] The "successful" prediction, of course, necessarily means confirmation or verification. Thus the validity or "predictive power" can always be evaluated by subsequent testing of the hypothesis. Medawar's statement on prediction follows, "If our predictions are borne out (logical, not temporal predictions), then we are justified in 'extending a certain

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[65]Charters, loc. cit.

[66]Louis I. Kuslan and A. Harris Stone, Teaching Children Science: An Inquiry Approach (Belmont, Calif.: Wadsworth Publishing Company, 1968), p. 26.

[67]Kerlinger, op. cit., p. 22.

[68]Cohen and Nagel, op. cit., p. 208.

[69]Ibid., p. 210.

confidence to the hypothesis'."[70]

It must be repeated that the primary purpose of a hypothesis is to determine the relationship amongst variables by constructing some explanation that contributes to the production or support of some generalizable law. Prediction postulates what this relationship might be, which can then be determined by the testing which the prediction allows. Kerlinger clearly makes this point. Of an hypothesis he says,

> They are, in essence, predictions of the form, "if A, then B," which we set up to test the relation between A and B. We let the facts have a chance to establish the probable truth or falsity of the hypothesis.[71]

The real significance of prediction for hypothesizing is most clearly enunciated by Stephens:

> Another way to judge hypotheses is according to their success at prediction. On the basis of an hypothesis, one predicts as yet unobserved events. Then one makes the observations necessary to check on the accuracy of the prediction: one tests the predictions. If the predictions are generally confirmed, then the hypothesis is viewed as "good," prestigeful, useful. . . . Also, the greater the precision of the predictions--the lower the margin of error--the more prestigeful, powerful, useful is the hypothesis. . . . Officially, at least, hypotheses are no longer believed or doubted . . .; rather they are tentatively "entertained," ranked in prestige, according to their demonstrated predictive utility.[72]

A problem usually associated with the problem of testing concerns dealing with a hypothesis somewhat removed

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[70]Medawar, loc. cit., citing C. S. Peirce, collected papers, eds., C. Hartshorne and P. Weise (Harvard, 1933-1935).

[71]Kerlinger., loc. cit.

[72]Stephens, op. cit., pp. 16-16.

in abstraction from the empirical or phenomenal world. The prediction must be so made that directions for testing are either explicit or implicit--the latter meaning that the prediction would be "translatable" into testable terms. Explaining this requirement Searles writes:

> . . . that an hypothesis be so conceived and so formulated as to be susceptible to deductive and mathematical development of its consequences, so that they may be compared with facts implied by the hypothesis; that is, it should have predictive power. This is especially necessary in hypotheses which cannot be verified directly.[73]

In turning to characteristics or criteria considered necessary for the functioning of an hypothesis, the criterion most crucial to particularly the last mentioned function is the first discussed.

Testability. According to Charters, an hypothesis, ". . . must be testable: . . . shaped . . . by considerations of what can be tested or what can be measured at the operational level."[74]

An hypothesis must yield to measurement for testing at the empirical level for various reasons, some of which have already been given. How else, but by the means of testing, can an hypothesis be evaluated as to its ability to achieve its major functions? The main "aspiration" of a hypothesis is to be able to approach the status that will permit generalizability to all cases to which it might refer.

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[73] Searles, op. cit., p. 16.

[74] Charters, op. cit., p. 16.

To achieve this status it must be founded on evidence; it must be verified--either directly, or indirectly pending deduction. Verification, in turn, can only be gained through testing. The Standard Dictionary most aptly explains this need for verification:

> . . . a hypothesis is a comprehensive tentative explanation of certain phenomena which is meant to include all other facts of the same case, and which is assumed as true till there has been opportunity to bring all the related facts into comparison; if the hypothesis explains all the facts it is regarded as verified. . . .[75]

As stated before, the basic purpose of the hypothesis or explanation is to "contribute to the production or support of some law." In this regard the linking function (between theory and evidence) can be recalled, and the accompanying need for testability determined. Kerlinger defines this need, declaring that testability will, ". . . enable the researcher to deduce specific empirical manifestations implied by the problems and hypotheses,"[76] and, since, "hypotheses incorporate the theory, or part of it, in testable or near-testable form . . . problems and hypotheses advance scientific knowledge by helping the investigation to confirm or disconfirm theory."[77] The need for "fusing" the evidence with prior knowledge or theory via verification is well stated by Hibben.

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[75] Standard Dictionary, op. cit.

[76] Kerlinger, op. cit., p. 23.

[77] Ibid., p. 24.

> We must abide content if our hypotheses are thinkable and useful, if they are capable of explaining all inter-connected appearances, even such as were still unknown when we constructed them . . . if that is to say, they are indirectly confirmed by the agreement of all that can be deduced from them in thought with the actual progress of experience.[78]

Searles reiterates this need for testability: "Since the main purpose of an hypothesis is to explain, bring into order, and summarize a body of facts in the form of a possible law the first criterion of a good hypothesis . . . is that it be testable."[79]

Further, looking at a "supportive" function of hypothesis, as Burton claims, an important requirement of a hypothesis is that it, ". . . answers the question it was designated to answer."[80] This ability might include the capacity to solve or explain. Determination of the success of a hypothesis in doing so depends entirely on testing.

More generally speaking, as Pierce claimed of predictability, testability, in the <u>final</u> analysis, determines the amount of "confidence" that can be attributed to a hypothesis. That is, validity is determined by the success of prediction which in turn is dependent for assessment upon testing. Of course, this could be expanded to say that an hypothesis' validity in terms of its success in accomplishing <u>any</u> of its necessary functions is dependent for measurement

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[78]Hibben, <u>op. cit</u>., p. 302, citing Lotze, <u>Logic</u>, p. 353.

[79]Searles, <u>op. cit</u>., p. 237.

[80]Burton, <u>op. cit</u>., p. 67.

on the testing of the hypothesis.

Also, knowing how to choose the "best" hypothesis (according to function(s) desired) when alternatives are often available demands some means of evaluation. This evaluation takes the form of testing in the available evidence. Cohen and Nagel make this point:

> Since there is a plurality of possible hypotheses, it is the task of inquiry to determine which of the possible explanations or solutions of the problem is in fact in agreement with the facts.[81]

Barker has perhaps phrased the general need for the testable criterion most succinctly: "Of course it is not enough merely to be supplied with a mass of uncriticized hypotheses, however; only insofar as we are able to evaluate these hypotheses do we possess knowledge."[82] Wolf, however, has undoubtedly produced the more convincing rationale for testability, in describing its function in scientific inquiry:

> Science begins with facts of actual observation, and constantly returns to observations, in order, directly or indirectly, to check all its tentative explanations or hypotheses. A suggested explanation which cannot, directly or indirectly, be put to the test of observation, so as to be either confirmed or confuted by it, is of no use in science . . . . The scientific hypothesis must not only account for all the observations already made of the phenomenon concerned but must be capable of being definitely confirmed or confuted by further observations, or experiments under specified conditions.[83]

Testability, in view of these essential functions

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[81]Cohen and Nagel, op. cit., p. 393.

[82]Barker, op. cit., p. 26.

[83]Wolf, op. cit., p. 30.

that it fulfills, must be considered a very necessary factor. Realizing this, many writers are very adamant in stressing the need for this criterion. Wolf has declared that,

> In science, . . . no hypothesis is seriously entertained unless it can be put to the test of observation, either directly or indirectly. . . . science has no use for barren hypotheses, that is, hypotheses which cannot be put to the test.[84]

Hibben rather dramatically states the ramifications of the testability criterion:

> The hypothesis that leads to verification by experiment represents true scientific procedures and that which has actually been the most effective instrument of research in all the various spheres of human investigation.[85]

Yet, as Hibben points out, not all testing must involve experimentation.

> The second requirement is that the hypothesis must be capable of proof or disproof. This does not demand a test by experiment necessarily; . . . it does, however, require that some facts should be forthcoming that will either confirm the hypothesis or disprove it.[86]

Perhaps the important nature of this criterion, as for the "guiding" function, will appear most evident by noting its position and status in the problem solving or inquiry process. Kerlinger provides this information by sketching the customary procedure:

> Man observes a phenomenon. He speculates on possible causes. . . . it is the scientist's business to doubt

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[84] Ibid., p. 155.

[85] Hibben, op. cit., p. 312.

[86] Ibid., p. 301.

> most explanations of the phenomena of his field. His doubts are systematic. He insists upon subjecting explanations of phenomena to controlled empirical test. . . . in order to do this, he must so formulate explanations that they are amenable to controlled empirical test, . . . he formulates the explanations in the form of theories and hypotheses. In fact, the explanations are hypotheses. The scientist simply disciplines the business by writing systematic and testable hypotheses.[87]

To introduce a final consideration respecting testability, it is to be noted that the assertion that explanations (hypotheses) be "amenable to test" does permit a wide scope for interpretation. That is, an hypotheses does not have to yield to direct testing; it may yield only to some form of indirect testing. So the only requirement is that, if tested precisely as stated, it must yield to logical reduction and/or deduction to a testable form.

Searles is referring to this indirect sense of testability when he states that,

> There is one rule, . . . which if violated leads to a stalemate and therefore constitutes a fallacy. It is that an hypothesis should be of such a nature that its consequences can be deduced, in order to be confirmed or refuted. If it cannot be so formulated, it is highly improbable that it will account for the facts. For example, the hypothesis that the suspected occupant of a certain house is a ghost is impossible of confirmation (either directly or indirectly) by any means known to science, and hence it is not very useful as an hypothesis.[88]

Kerlinger makes reference to the indirect method of testing:

> Hypotheses, if properly stated, can be tested. While a particular hypothesis may be too broad to be directly

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[87] Kerlinger, op. cit., p. 27.

[88] Searles, op. cit., p. 266-67.

> tested, if it is a "good" hypothesis, then, as indicated . . . other testable hypotheses can be deduced from it.[89]

Cohen and Nagel talk of "deducing other consequences" for discovering the relations between the "relevant factors" to permit more direct verification.[90] They then elaborate on the indirect testing process. In doing so, they, along with Kerlinger,[91] stress the need for the initial hypothesis to possess clear implications for testing: Cohen and Nagel write:

> It is often the case--indeed the most valuable hypotheses of science are of this nature--that a hypothesis cannot be directly verified.
>
> The hypothesis must be so stated that by means of the well-established techniques of logic and mathematics its implications can be clearly traced, and then subjected to experimental confirmation.
>
> Unless each of the constituent terms of a hypothesis denotes a determinate experimental procedure, it is impossible to put the hypothesis to an experimental test.[92]

So they conclude that "the necessary feature of an hypothesis, from this point of view, is that it should be statable in a determinate form, so that its implications can be discovered by logical means."[93]

Testability may safely be considered the most vital characteristic of an hypothesis. As mentioned, it is the quality most relied upon by an hypothesis in its attempt to fulfill the tasks which justify its existence. There are,

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[89] Kerlinger, _op. cit._, p. 23.

[90] Cohen and Nagel, _op. cit._, pp. 205-06.

[91] Kerlinger, _op. cit._, p. 23.

[92] Cohen and Nagel, _op. cit._, p. 207.

[93] _Ibid._, p. 393.

nevertheless, other characteristics or criteria which, while less significant, do facilitate the accomplishment of the job for which an hypothesis is designed.

One of these has already been discussed in connection with the directing and guiding function of an hypothesis as it is applied to available data.

Position preceding research. As Charters puts it, "The hypothesis is stated in advance of research."[94] Since elaboration is hardly necessary it shall be considered sufficient to say that this feature is essential to the provision of an antecedent means of prediction and control to precede all research or exploration. This must be the "order of things" because any research or investigation of empirical data, and the manipulation of variables in accordance with these data, demands some technique or medium by which those data and variables can be measured, organized, and controlled. An hypothesis produced prior to research serves to do this.

Clear statement. Another important criterion of an hypothesis is that it be clearly stated. Charters describes this need in the following manner: "An hypothesis . . . must be unequivocal in its prediction."[95] That is, the meaning that it conveys must be unambiguous. As Charters declares, "If the hypothesis is ambiguous, the researcher has no basis

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[94] Charters, op. cit., p. 2.

[95] Ibid.

for deciding whether his observations support or deny it (such that anything that is observed to happen can be construed as supporting it)."[96] But perhaps even more importantly, ". . . it offers the researcher no grounds for determining whether the reasoning that led to the formulation of the hypothesis is correct or incorrect. . . ."[97]

Obviously this requirement encourages all aspects of an hypothesis' functioning, but it particularly enhances the accuracy of predictability and, subsequently, testability. Barker indicates this association: "The better confirmed hypothesis is to be the one which 'says more,' which 'forbids more,' which is the 'more testable.'"[98] Cohen and Nagel are considering the importance of clear, unambiguous stipulation of requirements and conditions to allow testing where they say, "It follows that unless a hypothesis is explicitly or implicitly differentiating in the order it specifies, it cannot be regarded as adequate. . . ."[99] Hibben requires that "an hypothesis should involve no contradiction."[100] Finally, Burton emphasizes the need to prevent ambiguity by stating the hypothesis in defined terms.[101]

Simplicity. A closely associated and oft repeated

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[96] Ibid.

[97] Ibid.

[98] Barker, op. cit., p. 157.

[99] Cohen and Nagel, op. cit., p. 211.

[100] Hibben, op. cit., p. 308.

[101] Burton, loc. cit.

criterion can be termed "simplicity." Charters phrases this necessary characteristic as follows: "In practice, the . . . hypothesis is stated in a sentence or two and focuses on the most <u>salient</u> features of the method employed."[102] This could feasibly be translated to say, "An hypothesis must be as brief and concisely worded as possible."

Burton explains the principle of choosing between alternative hypotheses on the basis of simplicity:

> . . . when there is a choice between hypotheses which seem to furnish answers to a question dealing with theoretical systems, the simplest is often preferable, that is, the hypothesis which has the fewest elements and furnishes the most direct solution. When simple ones have been exhausted, it will be time for more complex and subtle statements.
>
> The principle that the simplest solution should be accepted first is often called the Law of Parsimony: Select the solution which has the fewest residual phenomena. It is often called also, Occam's Razor, after William of Occam who first stated the principle.[103]

Searles elaborates on the principle, listing it as one of the criteria for a good hypothesis,

> This principle states that economy and simplicity should be observed in the selection of hypotheses, but it requires great care in interpretation. It does not mean that the simplest hypothesis is always the true one, but rather that when there are competing hypotheses, ordinarily the simplest hypothesis that will account for the facts should be chosen.[104]

Hibben simply affirms that "the hypothesis should be as

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[102]Charters, *op. cit.*, p. 4.

[103]Burton, *op. cit.*, p. 68.

[104]Searles, *op. cit.*, p. 238.

simple as possible."[105]

Just how is simplicity determined? On what grounds is an hypothesis considered "simple"? Burton interprets this concept as characterizing a hypothesis "having the fewest elements and furnishing the most direct solution." Barker considers the simplest hypothesis to be the one best supported by the evidence.[106] Although this latter notion hardly concurs with Searles' position that "it is not always the true one," both Burton's and Barker's conceptions do require that the hypothesis yield as directly as possible to testing. Perhaps then, simplicity, as "clear statement," is but another feature of testability.

Barker speaks of three respects in which hypotheses seem to admit of variations in simplicity.

> They may vary with regard to (1) the number of individual entities which they assert to exist; (2) they may vary with regard to the number and complexity of the independent concepts (or kinds of entities) which they involve; and (3) they may vary in the number and complexity of the statements which they contain.[107]

It is not clear which type of simplicity Burton was referring to but Cohen and Nagel must be speaking of the second mode of determination when they state that, "One hypothesis is said to be simpler than another if the number of independent types of elements in the first is smaller than in the second."[108]

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[105] Hibben, op. cit., p. 308.

[106] Barker, op. cit., p. 94.

[107] Ibid., p. 163.

[108] Cohen and Nagel, op. cit., p. 213.

A very similar notion to that of providing the most likely solution, as shown by the evidence, is Cohen and Nagel's "alternate" explanation of simplicity. They interpret simplicity as being synonymous with order and systematization. Since systematization involves congruity with and amongst the facts, the two notions are not dissimilar. This is what they have to say,

> We are thus led to recognize another sense of simplicity. Two hypotheses may be both capable of introducing order into a certain domain. But one theory may be able to show that various facts in the domain are related on the basis of the systematic implications of its assumptions. The second theory, however, may be able to formulate an order only on the basis of special assumptions formulated ad hoc which are unconnected in any systematic fashion. The first theory is then said to be simpler than the second. Simplicity in this sense is the simplicity of system. A hypothesis simple in this sense is characterized by generality. One theory will therefore be said to be more simple or general than another if the first can, while the second cannot, exhibit the connections it is investigating as special instances of the relations it takes as fundamental.[109]

The implication of the last sentence of this passage is that such an organized, rigorous, or simple hypothesis with an encompassing, but definite, application would more readily yield to testing (furnishing the most direct solution).

The foregoing list of functions and criteria exhausts the treatment given by Charters. However, interest is shown by the selected writers in various other characteristics or criteria of an hypothesis. Only a few of these, on which there exists reasonable consensus regarding their importance, will be reviewed for purposes of this analysis.

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[109] *Ibid.*, p. 214.

Falsity. To be valid an hypothesis does not have to be true; false ones can be equally instrumental. Cohen and Nagel clearly make this point:

> Hypotheses can be regarded as suggestions of _possible_ [italics not in the original] connections between actual facts or imagined ones. The question of the truth of hypotheses need not, therefore always be raised. . . .[110]

and Dewey has said of an hypothesis:

> It must be of the nature of a vera causa. Being a vera causa, does not mean, of course, that it is a true hypothesis, for if it were that, it would be more than a hypothesis.[111]

Apart from the fact that "truth" in respect to an hypothesis can only at the outset be supposed, postulated, _hypothesized_, it is difficult to graduate to "absolute" truth under any circumstances; truth must be assessed in terms of degree. Cohen and Nagel explain:

> Since there is a plurality of possible hypotheses, it is the task of inquiry to determine which of the possible explanations or solutions of the problem is in _best_ agreement with the facts.
>
> No hypothesis which states a general proposition can be demonstrated as absolutely true. We have seen that all inquiry which deals with matters of fact employs _probable_ inference. The task of such investigations is to select that hypothesis which is the most probable on the factual evidence. . . [italics not in original].[112]

A statement made by Stephens endorses this position: "Hypotheses presume to describe the external reality, and are ordinarily considered as not subject to proof--only to

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[110] _Ibid_., p. 393.

[111] Dewey, _Logic--The Theory of Inquiry_, _op. cit_., p. 3.

[112] Cohen and Nagel, _op. cit_., p. 393.

partial and tentative verification. . . ."[113]

Dewey, following his affirmation that a hypothesis cannot by its very nature be initially considered true, proceeds to explain why. He considers such an attempt even detrimental to the "scientific quest":

> It is notorious that a hypothesis does not have to be true in order to be highly serviceable in the conduct of inquiry. . . . Just as it would be hard to find an instance of a scientific hypothesis that turned out to be valid in precisely the same form in which it was first put forward, so it would be hard in any scientific undertaking to find an initial proposition about the state of facts that has remained unchanged throughout the course of inquiry in respect to its content and significance. The history of science also shows that when hypotheses have been taken to be finally true and hence unquestionable, they have obstructed inquiry and kept science committed to doctrines that later turned out to be invalid [italics in the original].[114]

Adopting another angle, three of the writers reveal the acceptability, and even preferability, of "non-true" hypotheses by demonstrating the utility of false hypotheses. Wolf claims that false hypotheses can be fruitful since they suggest lines of investigation that may lead to the discovery of truths. He also points out that such hypotheses may at some future time become fruitful when suitable scientific "techniques" have been invented.[115] Hibben points out that the failure of an hypothesis may lead to the readjustment of "established" theory, or it may stimulate research to find

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[113]Stephens, op. cit., p. 3.

[114]Dewey, Logic, op. cit., p. 142.

[115]Wolf, op. cit., p. 156.

the "correct" hypothesis.[116] Cohen and Nagel claim that a false hypothesis may direct attention to unsuspected facts or relations between facts, and so provide evidence for certain theories.[117]

It cannot be known prior to testing whether an hypothesis is true or false. To claim such knowledge, as Dewey points out, an hypothesis cannot suffice, since by its very nature it must remain tentative. It is entertained only by virtue of its status, given the available information, of being "likely true"; probably true. Only empirical testing can decide the validity of the choice. Prior grounding in theory and in evidence can only affect the probability of its "truth" value. Thus not only does an hypothesis not have to prove true in the "end" to be useful in the inquiry process, its "truth-status" can only be supposed or suggested prior to that point. In this statement resides the transition to another very similar characteristic.

<u>Tentativeness</u>. An hypothesis always possesses a strictly tentative nature. This fact has already been pronounced in the foregoing analysis (e.g., Dewey). To better explicate this point a few other writers can be quoted. Burton writes, "There can be no guarantee in advance that the 'unknown,' the possible but as yet absent conclusions

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[116] Hibben, <u>op. cit</u>., p. 308.

[117] Cohen and Nagel, <u>op. cit</u>., p. 207-08.

or facts, will be correct or useful. Proof of hypothetical conclusions is always necessary."[118] Medawar states, "We assert a postulate and take an axiom for granted, but hypotheses we merely venture to propose. (We believe in hypotheses, of course, but only for the sake of argument and as an incentive to critical inquiry)."[119] Finally, Dewey, like Cohen and Nagel earlier, declares that, "Any suggested or indicated mode of solution must be formulated as a possibility. Such formulation constitutes a hypothesis."[120]

The foregoing functions, and criteria or characteristics, some of which are more obvious and familiar than others, shall, for purposes of this analysis, be deemed to constitute the primary considerations. Certain other functions and characteristics that may appear either overly obvious, or too nearly synonymous with those already covered, are not being subjected to analysis. This lack of tribute is in no way meant to diminish their significance. Obvious functions, not separately analyzed but incorporated in--or mentioned in regard to--functions dealt with, relate to the purposes of providing a solution, answering a question, or producing an explanation. Other rather basic attributes

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[118] Burton, op. cit., p. 68.

[119] Medawar, op. cit., p. 47.

[120] Dewey, op. cit., p. 427.

discussed in diverse contexts, but not considered as needful of separate treatment, are validity, generalizability, plausibility, and probability.

It must always be kept in mind that an hypothesis is no more than a tool, an instrument, however important its situational purpose might be. As Kerlinger said, "they are working instruments of theory . . .," and, in connection with this aspect, they involve the production of logical inferences, employing both deductive and inductive "thought links" in scientific investigation. The latter aspect will be better developed in the following section.

Origin

Origin, in keeping with Dewey's use of the term, will in definition be given a wider scope than is customary. The concept will be considered to include both basis or source and the actual process of formulation or construction. Although the term origin normally is used in reference to basis (where the hypothesis comes from), the two aspects are closely related.

Of origin Dewey has this to say,

> In the various discussions of the hypothesis which have appeared in works on inductive logic and in writings on scientific method, its structure and function have received considerable attention, while its origin has been comparatively neglected.[121]

This component, if commonly neglected, is

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[121] Dewey, Studies in Logical Theory, op. cit., p. 142.

quite thoroughly analyzed in this chapter.

Basis. Beginning then with the aspect of "basis" or "source," the origin of hypotheses as discussed by some of the writers is explored. Gregory has this to say:

> There must be knowledge before any useful hypothesis or assumption can be formed as to what should follow from it. The hypothesis which represents an effort of imaginative power not funded upon a wide range of facts may pass as fiction, but it has no place in science.[122]

Burton concurs, stating that the hypothesis be, ". . . compatible with existing knowledge; in accord with human concepts and laws."[123] He also stresses that it be based on the,". . . facts in the original situation out of which the problem arose."[124] Here then is shown the need to "conform" to two types of knowledge: the facts or evidence of the circumstances related to the problem area of interest, and generally established knowledge in the form of laws and theory that relate to the first type. Cohen and Nagel are really referring to the need for both types of knowledge in stating,

> Such tentative explanations are suggested to us by something in the subject matter and by our previous knowledge.
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> . . . .
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> In the absence of knowledge concerning a subject matter, we can make no well-founded judgements of relevance. . . . The hypotheses which occur to an

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[122]Arman, loc. cit.

[123]Burton, op. cit., p. 63.

[124]Ibid., p. 67.

> investigator are therefore a function, in part at least, of his previous knowledge.[125]

The word "conform" was used, but more than merely conforming to (in the sense of fitting into) knowledge an hypothesis may actually be produced <u>from</u> this knowledge. Of course in one way this is true of any hypothesis, since no hypothesis can evolve from nothing. Yet evolving from nothing and being produced from necessary facts, but in a "vacuum," are two impossibilities representing rather separate issues. That is, in one case the contribution of existing knowledge spoken of is direct; in the other it is only indirect. The concern shown in the previous quotes was primarily for the indirect influence. The role of knowledge in directly <u>producing</u> hypotheses is being referred to by Ruby, where he states that,

> Previous knowledge, however, is always of great importance for genius and non-genius alike. Previous knowledge may even give us our explanatory hypotheses, when we suddenly see the connection between an observed fact and a known principle.[126]

Searles, it would appear, speaks of the more direct connection in saying that,

> Hypotheses are suggested by the knowledge of the field already possessed by the scientist. The more thorough and extensive the knowledge of the field, the more likely the hypothesis is to be adequate to explain the facts.[127]

Dewey is definitely concerned with the direct derivation

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[125]Cohen and Nagel, <u>op. cit</u>., pp. 201-02.

[126]Ruby, <u>op. cit</u>., p. 253.

[127]Searles, <u>op. cit</u>., p. 231.

from knowledge as he affirms, in referring to an hypothesis,

> It must be of the nature of a vera crusa. [This] . . . means that whatever is offered as the ground of a theory must possess the property of verifiable existence in some domain, no matter how hypothetical it is in reference to the field in which it is supposed to apply to it. It has no standing if it is drawn from the void and proffered simply ad hoc.[128]

He then deals with the other type of knowledge, however, in a more indirect fashion.

> The second condition that a hypothesis about ultimate logical subject-matter must satisfy is that it be able to order and account for what has been called the proximate subject-matter. If it cannot meet the test thus imposed, no amount of theoretical plausibility is of avail.[129]

Basis on, or origin in, the more general and comprehensive knowledge that yields assumptions, axioms, postulates, laws, and theory of varying degrees of substantiation, however, requires more emphasis. Recalling the "linking" function of an hypothesis it should be acknowledged that grounding in varying levels of theory is a necessary criterion of an hypothesis. Of course, such knowledge is produced and revealed solely by the accumulated experiences of many people. That is why reliance on one's individual experience as mentioned earlier, while necessary, is inadequate. As Searles states, "The scientific hypothesis must . . . account for all the observations already made of the phenomenon concerned. . . ."[130] Stephens echoes this in talking of

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[128] Dewey, Logic, op. cit., p. 3.

[129] Ibid.

[130] Searles, op. cit., p. 30.

considering only incoming hypotheses which "seem to agree with previously held beliefs."[131]

In connection with direct derivation from theory, Kerlinger calls hypotheses the working instruments of theory and mentions that they can be deduced from theory and other hypotheses.[132] Bosanquet's explanation of a postulate subsuming a hypothesis is very similar. Searles considers "vague working ideas" or "assumptions" to be at the back of hypotheses.[133] Searles also holds that an hypothesis must be consistent with ". . . the presuppositions, postulates, principles, and already verified facts in the field of investigation."[134] Medawar shows how direct this derivation can be, where he says, to repeat, that one theory may represent the starting point, namely the hypothesis, of another theory. Dewey talks of "attachment" to theory as well, when he talks of "developing in relation to other conceptual structures." However, Dewey does add to those "knowledge" categories discussed above a third, but associated, source for hypotheses.

> In the third place, the hypothesis must be such as to account for the arguments that are advanced in support of other theories. This condition corresponds to the capacity of a theory in any field to explain apparent negative cases and exceptions.[135]

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[131] Stephens, op. cit., p. 15.

[132] Kerlinger, op. cit., p. 22.

[133] Searles, op. cit., p. 198.

[134] Ibid., p. 189.

[135] Dewey, Logic, op. cit., p. 3.

Of course, this source is really just an extension of the one being discussed, being included by the conception, general knowledge or general theory.

An equally important source or base for the creation of hypotheses has to do with the way in which the human mind typically initiates the production of hypotheses. Key terms referring to this intellectual operation are "guessing," "imagining," or "supposing." This mode of originating is not incompatible with, but really complementary to, that source already discussed; both are necessary. Their "inter-functioning" is revealed by Gregory as he describes the process of development. The investigator begins with the,

> . . . results of observation or experiment, . . . guesses at their meaning . . ., [and] . . . invents an hypothesis which will not only explain what is known, but also suggests consequences which may, or may not, be confirmed by future investigations.[136]

From this it is evident that, even though the initial basis must be provided by prevailing suppositions and knowledge (results of observation or experiment), guessing is necessary to extrapolate, to go <u>beyond</u> the evidence, in inventing (not just replicating) an hypothesis. The role of this "guessing" element is aptly described by Hibben. Again, nevertheless, the necessity of foundation on evidence, in spite of the "leeway" permitted for imagination, is stressed:

> It will be noticed . . . how large a part is played by imagination. It is the imagination which fills

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[136] Arman, <u>op. cit</u>., p. 162.

> out the vacant spaces in the picture of perception. . . . It must, in this connection however, be clearly emphasized that the imagination which constructs hypotheses must be throughout in touch with fact.[137]

Searles adds to his prior consideration for the importance of "knowledge of the field," "imagination and scientific genius."[138] Cohen and Nagel, as well, make allowance for some degree of "self-determination" in claiming that hypotheses are a "function" of imagination.[139] Medawar, quoting Popper, states, in referring to one aspect of science, "In the imaginative episode we form an opinion, take a view, make an informed guess, which might explain the phenomena under investigation. The generative act is the formation of an hypothesis. . . ."[140] The real significance of this "guessing" element is supplied by Ruby.

> . . . where did the explanatory hypothesis come from? . . . could it be a "flash of insight" or "intuition," requiring imagination . . .? A great explanatory hypothesis involves the ability to see new connections, and new abstract relationships. Thoroughness of research may often be a satisfactory substitute for imagination, as in industrial research, but in the higher levels of science it is never a complete substitute.[141]

Even though degree of "validity" is often decided on the basis of amount of evidence or proof (plausibility) by appealing to the facts, some writers apparently consider this

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[137] Hibben, op. cit., p. 299.

[138] Searles, op. cit., p. 231.

[139] Cohen and Nagel, op. cit., p. 392.

[140] Medawar, op. cit., citing Karl Popper, p. 46.

[141] Ruby, op. cit., p. 253.

criterion too rigid; too restrictive; too hindering to fruitful scientific investigations. Burton, for one, makes this point.

> Hypotheses may range from very plausible answers to wild guesses, "shots" in the dark. Both should be given a hearing. Many plausible guesses turn out to be only remotely related to the problem. Sometimes great advances in intellectual life, both for individuals and for society, have resulted from pursuing what seemed to be "wild guesses."[142]

A legitimate question in connection with the foregoing might be phrased in these ways: "How can this phenomenon of imagining be assessed?" ,"Are there any criteria by which to judge the 'mechanics' of this process?" or "Does any 'formula' for this mode of production exist?" Apparently there exist no satisfactory answers to such questions. There simply is no simple explanation. Burton indicates this fact:

> . . . Where do our hypotheses come from? Our intuitions, guesses, hunches? From the "vastly deep" of our life experience. Out of nowhere into the here. But do they always come quickly and easily when we call? No! The authors cannot teach anyone to call even the lesser spirits, let alone, "to command the devil!"[143]

Dewey very explicitly states the case:

> The first suggestion occurs spontaneously; it comes to mind automatically; it _springs_ up; it "pops" as we have said, "into the mind"; it flashes upon us. There is no direct control of its occurrence; the idea just comes or it does not come; that is all that can be said. There is nothing intellectual about its occurrence.

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[142] Burton, _op. cit._, p. 64.

[143] _Ibid._, p. 63.

> The intellectual element consists in what we do with it, after its sudden occurrence as an idea [italics in the original].[144]

Formulation. Principles for intellectually developing the hypothesis, once it has "sprung," can be laid down. The main requirement in this regard, as previously suggested, is that it always accord with evidence which is available. So Dewey continues,

> A controlled use of it is made possible by the state of affairs just described. In the degree in which we define the difficulty (which is effected by stating it in terms of objects) we get a better idea of the kind of solution that is needed. The facts or data set the problem before us, and insight into the problem corrects, modifies, expands the suggestion that originally occurred. In this fashion the suggestion becomes a definite supposition or, stated more technically, a hypothesis.[145]

Essentially the same stance is taken by Burton in analyzing the "building" process once the intuition, guess or hunch has occurred,

> The mind naturally and usually begins at once to suggest answers, to gather evidence, to begin organizing arguments, to make inferences. Here we have the discursive phase of thinking . . .: good guesses and errors, corrections, redefinition of terms, digressions, shuttling back and forth between facts and hypotheses.[146]

The line being drawn between source or basis and actual formulation is very thin indeed. One aspect really "blends" into the other. So the last passages quoted above, though seemingly emphasizing basis, delve into formation,

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[144] Dewey, How We Think, op. cit., p. 109.

[145] Ibid., pp. 109-10.

[146] Burton, op. cit., p. 64.

going a step beyond the initial origin.

Though there is no logic of discovery as such, the fundamental procedure involved in the process of formulating hypotheses is a logical movement, normally from the specific and concrete to the general and abstract, employing inference. Dewey has this to say of inference:

> Inference in logical terms is the act of concluding that propositions before us imply new propositions and . . . inference is the central movement in all thinking. It is the movement from facts to the tentative explanation (hypothesis), from one reason to another, from a reason to predicted new facts, toward acceptance or rejection of a conclusion. Thus inference is the heart of thinking. It is often referred to as a "leap" or "jump." The thinker observes facts which are real, can be measured, or otherwise handled, and then he "leaps" to an explanation.
>
> Systematic inference, in short, means the recognition of definite relations of inter-dependence between considerations previously unorganized and disconnected, this recognition being brought about by the discovery and insertion of new facts and properties.[147]

It is clear in this explanation that a major function of an hypothesis, that of organizing and controlling data collection, to a great extent determines its formation. That is, the inferential movement involves systematization by "filling out the field." Burton affirms the necessity of inference in hypothesizing, but recognizes an inevitable difficulty, a risk which of course must be gambled on for knowledge to advance. He says,

> The emergence of the hypothesis is an inference. Minor inferential movements take place constantly as the inference is elaborated and finally tested. Inference

[147]Dewey, How We Think, op. cit., p. 68.

> since it moves from something known to something unknown is peculiarly susceptible to error.[148]

Inference, as emphasized by Dewey, may take many forms, since it works in "divers manners." And, as already implied, hypothesis formation makes use of more than one of these modes of inferring. Cohen and Nagel distinguish one, in reference to choosing between alternatives (one aspect of producing an hypothesis):

> There is a need, therefore, for a technique to choose between the alternative suggestions, and to make sure that the alternatives are in fact, and not only in appearance, different theories. Perhaps the most important and best explored part of such a technique is the technique of formal inference.[149]

The same authors then speak of the importance of logic (presumably involving inference) for apparently the same purpose.

> We need a technique that will enable us to discover possible alternatives to propositions which we may regard as truisms or necessarily true. In this process formal logic aids us in devising ways of formulating our propositions explicitly and accurately, so that their possible alternatives become clear.[150]

Dewey in one statement is essentially speaking of the two types of logic primarily used in hypothesis inferencing:

> (1) The inductive phase consists of the complex of experimental operations by which antecedently existing conditions are so modified that data are obtained which indicate and test proposed modes of solution. (2) Any suggested or indicated mode of

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[148] Burton, op. cit., p. 68.

[149] Cohen and Nagel, op. cit., p. 392.

[150] Ibid., pp. 195-96.

> solution must be formulated as a possibility. Such formulation constitutes a hypothesis. The "if-then" proposition which results must be developed in ordered relation to other propositions of like form (or in discourse), until related contents are obtained forming the special "if-then" proposition that directs experimental observations yielding new data.[151]

The various requirements, including mechanics, of forming an hypothesis have just been dealt with. A valid question might be whether these demand any particular disposition or special abilities on the part of those that attempt to construct hypotheses? It might more appropriately be queried, "what disposition or attitude and abilities are conducive to the production of the most 'viable' hypothesis--that is, the one most closely approaching that characterizing the standards and stipulations herein laid out?" Burton, for one, has a definite answer:

> The untrained person, the inexperienced thinker, or the stupid person often seizes upon the first answer (hypothesis). He "jumps to conclusions." He "begins with certainty" and, hence, blocks further thinking. The trained thinker, or the naturally shrewd person, has learned that it is necessary (a) to call up as many tentative answers (hypotheses) as possible, and (b) to look for associations, implications, related ideas of any sort which will lend or deny support to one of the original hypotheses. The trained thinker "begins with doubt" or at least suspended judgement. As Dewey points out, this is not always easy: "Reflective thought is always more or less troublesome because it involves overcoming the inertia that inclines one to accept suggestions at their face value; it involves willingness to endure a condition of mental unrest and disturbance.[152]

This "condition," then, constitutes the primary attitude

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[151] Dewey, op. cit., p. 427.

[152] Burton, op. cit., p. 64, citing Dewey, How We Think, p. 13.

or disposition necessary to fulfill the typical tasks involved in hypothesizing, realizing the abilities required of them. In respect to abilities, to supplement and partially replicate those implied by Burton; Searles, elaborating on his talk of "imagination" and "scientific genius," can be quoted: "We do not mean, of course, by 'scientific imagination' the undisciplined fancy of the child, but rather the ability to explore possibilities and anticipate nature in her devious ways."[153]

Searles then adds, and the investigator quotes in summarizing this section on origin:

> This is but another way of saying that it requires a high degree of scientific ability to propose relevant hypotheses. Almost anyone is capable of making vague guesses as to the possible implications of a body of accumulated facts or regarding the solution of a difficult problem, but only a few are capable of seeing all around the problem in the manner required to formulate an <u>adequate</u> and <u>successful</u> hypothesis [italics not in original].[154]

<u>Structure</u>

Structurally, an hypothesis consists basically of only two elements. Charters defines these as "(1) two variables (X and Y) and (2) the specification of relationship predicted to hold between them."[155] He then proceeds to describe a variable in this way:

> A variable refers to some way in which persons, objects, conditions, or events differ (or vary) from one time to

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[153] Searles, <u>op. cit</u>., p. 231.

[154] <u>Ibid</u>.

[155] Charters, <u>op. cit</u>., p. 18.

> another or from one case to another. Variables can be regarded as the attributes of a class (or category) of things.[156]

He supplies an example of such variables, ". . . people can differ in height, sex, aggressiveness . . . ad infinitum,"[157] where "height," "sex," and so on are the variables.

Charters then goes on to explain that variables have two features that the student must take account of, namely a referent and a mode of variation.[158] In the original illustration "people" is the referent, while "mode of variation" depends on the type of variable or attribute being considered. He recognizes two modes of variation: variation in kind and variation in degree. Charters states that "common synonyms for the two modes are qualitative and quantitative differences, or nominal measurement and ordered measurement (continuum, dimension, etc.)."[159] It is evident that in the example above the variables "height" and "aggressiveness" would vary by degree, while "sex" would entail variation in kind.

It should be pointed out that Charters in stipulating two variables is considering only his conceptual hypothesis. Later he states that every hypothesis has at least two variables, implying that some will have more. Now

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[156] Ibid., p. 18.

[157] Ibid.

[158] Ibid.

[159] Ibid., p. 19.

it was earlier determined that hypotheses vary only on the "generality" continuum. Thus arises the question of whether Charters is justified in limiting a structural requirement to any particular type of hypothesis. To remain consistent his conception allowing wider scope in permitting _any_ number of variables (but usually only two) will be considered to apply to all hypotheses.

Charters attests that the variables must share the same referent. If they share the same referent, they themselves must possess some relationship to one another; hence the second element outlined at the outset. A good example incorporating the referent and two variables is provided:

> The longer a child practices the multiplication table, the more rapidly he will be able to reproduce it on request.[160]

The referent is "child;" the two variables, "length of time practicing" and "speed of reproduction." Obviously the statement hypothesizes a direct relationship between the two.

In respect to the variables Charters also notes that (where two variables exist) it is conventional to use Y to indicate the dependent variable (that attribute which is to be explained) and X to indicate the independent variable (that attribute which is supposed to explain).[161] In effect, X is the cause; Y is the effect. In the foregoing example,

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[160] _Ibid._

[161] _Ibid._, pp. 21-22.

then, "length of practice" (X) is the independent variable, and "speed of reproduction" (Y) is the dependent variable.

Further, regarding the specification of the relationship, Charters states that "an hypothesis must specify precisely and unequivocally how variation in X is expected to relate to variation in Y. It cannot be left vague or in the form of a question."[162] He adds that it is generally easier to establish relationships when both variables are in "degree" than when one or the other is in "kind." And when in "degree" the relationship can be predicted to be either direct or inverse.[163]

Stephens has this to say of hypothesis structure (note how closely it correlates with Charters' analysis):

> All hypotheses will be construed as assigning variables to cases. The "case" is the entity or thing that the hypothesis talks about. The "variable" is the characteristic, trait, or attribute which, in the hypothesis, is imputed to the case.[164]

Kerlinger, in describing the hypothesis necessary for behavioral research, outlines definite requirements. First of all, he affirms that hypotheses are statements about relations between variables.[165] He then says of this relation, illustrating its operation,

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[162] Ibid., p. 26.

[163] Ibid.

[164] Stephens, op. cit., p. 6.

[165] Kerlinger, op. cit., p. 20.

> . . . here the relation is indirect, concealed as it were. It customarily comes in the form of a statement that Groups "A" and "B" will differ on some characteristic. For example, "Middle-class children more often than lower-class children will avoid finger painting tasks." Note that this statement is one step removed from the actual hypothesis which might be stated: "Finger painting behavior is in part a function of social class." If the latter statement were the hypothesis stated, then the first statement might be called a subhypothesis, or a specific prediction based on the original hypothesis.[166]

Kerlinger then goes on to consider another hypothesis which is still further "removed." It is clear, however, that irrespective of "level," that is, degree of "abstraction" distance from the concrete manifestation, he indicates one basic form: the hypotheses constitutes at least two variables, one a function of the other(s).

In dissecting the examples cited by Kerlinger, it is to be noticed that even though the wording differs the constituent elements do not. One variable, that of type, is "class." The other variable, a degree variable, is "avoidance" or "behavior"; the former, as Kerlinger points out, being more specific than the latter. Actually, the variable properly stated is "avoidance of finger painting tasks," but, of course, "finger painting tasks," as such, occupies the role of referent for both variables.

Thus Kerlinger's formulation not only supports the idea of unvarying structure or nature, but coincides with the analysis made by Charters. The requirements are most explicit.

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[166] Ibid., p. 21.

SUMMARY--PRODUCTION OF SCHEMA

For the purpose of producing a systematic and operational schema the findings of this chapter are synthesized and outlined in abbreviated point form. To structure a means of measurement for analyzing social studies writers the points have been individually numbered and coded. Room was left for any modification or addition suggested by the subsequent analysis of social studies writers. It is essential that the present schema be considered only a tentative, initiatory effort, subject to alteration in method or theory, as proven necessary.

A. FUNCTION

Primary Functions

1. The hypothesis links two worlds: the world of explanation and theory and the empirical world of phenomena and fact. It encourages the expansion of theory and knowledge. (F-1)
2. The hypothesis guides or directs research. It helps to specify what is to be measured. It determines what data must be collected. It governs the process and direction of data analysis. It, as well, organizes and systematizes data or information. (F-2)
3. The hypothesis predicts. It states explicitly what can be expected to happen under specified conditions. (F-3)
4. The hypothesis provides a real or potential answer, solution, or explanation.

<u>Supporting Characteristics</u> (criteria)

1. The hypothesis must be <u>testable</u>. That is, it must be shaped by considerations of what can be tested (measured) at the operational level. This requirement includes the idea of being able to assess the consequences, and hence may require logical deduction. (C-1)
2. The hypothesis must be stated in <u>advance</u> of research. (C-2)
3. The hypothesis must be <u>clearly</u> stated. It must be unequivocal in its prediction. (C-3)
4. The hypothesis must be <u>simple</u>. It must focus on the most salient features of the method employed. (C-4)
5. The hypothesis to be useful does not have to--nor cannot--be absolutely true. It may even be <u>false</u>. (C-5)
6. The hypothesis, by its very nature is always strictly <u>tentative</u>. (C-6)
7. The hypothesis must be <u>plausible</u> and <u>probable</u>. (C-7)

B. ORIGIN

<u>Basis</u>

1. The hypothesis must be based on, or be in accord with, prior facts, <u>knowledge</u>, or (O-1)

experience. This knowledge may be in the form of conceptual schemes, laws, or theories.

2. The hypothesis must concern the facts or subject-matter in the original situation out of which the problem arose. (O-2)

Formulation

3. The hypothesis must go "beyond" the facts, the evidence, or the current state of knowledge. This extrapolation requires an element of guessing, surmising, or imagining which in its inception is not entirely restricted by rational and logical considerations. That is, there is really no logic of discovery or conception. (O-3)

4. The hypothesis involves--subsequent to initial discovery--systematic inference: a logical process of reasoning inductively from the facts and/or deductively in relation to other more encompassing conceptual structures. (O-4)

C. STRUCTURE

1. The hypothesis must have at least two variables: one dependent; one independent. (S-1)

2. The hypothesis must specify the relationship between these variables (in a

particular case or situation); one must be a function of the other(s)--that is, an "if-then" association must exist. (S-2)

3. The hypothesis must contain variables that have two features: a common <u>referent</u> and modes of <u>variation</u>. (S-3)

In conclusion, it should be made clear that the ability to hypothesize depends on much more than just an acquaintance with--even an operational understanding of--an hypothesis' attributes and facts concerning its function, origin, and structure. The ability to hypothesize involves, perhaps even more importantly, an appropriate scientific and mental attitude or orientation. Nevertheless, it should be possible to approach the "ideal" hypothesis more closely through gaining a general understanding of the "workings" and anatomy of hypotheses. With hypothesizing considered the heart of the problem-solving and inquiry processes currently popular in social studies education, added incentive exists in this realm for knowing as much as possible about the concept, hypothesis, and hypothesizing. So the synthesis prepared within this chapter, beyond merely serving as an instrument for assessing the treatment of hypothesis by various writers in social studies, can hopefully provide a needed summary of some accumulated knowledge in this area.

Chapter 3

ANALYSIS OF SELECTED SOCIAL STUDIES LITERATURE

INTRODUCTION

In this chapter is reported an analysis of social studies writers that have produced work dealing with the concept, hypothesis, in the inquiry, problem-solving, or discovery processes. The analysis was made on the basis of the schema arrived at in the preceding chapter. Since the concern was to be limited to the secondary school, only those writers directing their efforts to the secondary school or those considering social studies from a general perspective--with implicit application to the secondary school situation--were selected for analysis. The selection has been further limited to relevant publications in Canada and the United States since 1960. The selection includes theorist and methodologist, whether writing in "methods books" as such; edited, multiple-authorship books; or related journal articles.

PROCEDURE

The work of each writer or, where necessary, group of writers is separately assessed. The writers that discuss any aspect regarding hypothesis, and thus have work that yields to some form of analysis by the constructed schema,

constitute the main section of this chapter, namely Category II. Those that, in the context of an exposition of the inquiry approach, no more than mention the hypothesis "step," solely make reference to the need to hypothesize, or merely quote another writer, are listed prior to the main analysis, in Category I.

To identify applicable aspects and generally rate each Category II production, a numbering system or code corresponding to the classification and sequence of the summary schema is utilized. Thus, major functions appear as "F-1," "F-2," "F-3," and "F-4"; associated characteristics as "C-1" through "C-7," and so on. Statements of the various writers that either stipulate or imply any of these eighteen points are assigned a symbol; in this way being designated according to the constructed code.

The various writers and their separate publications are then assessed by, first of all, simply enumerating the separate, individual points encountered. This is done for each category and for all combined. These figures are then compared with the potential (as per schema) category (4, 7, 4, and 3) and composite (18) totals. Secondly, to more validly assess the degree or depth of coverage for each writer, a cumulative enumeration of the frequency of reference to points of the schema is carried out. Ratings so derived are shown both following the analysis of each publication and section divided according to writer. Each summary table is then followed by a brief interpretation. Finally, yielding

relative ratings for writers and general coverage of the schema points, findings for all publications and writers are summarized.

CATEGORY I

1. Helen Carpenter--Skill Development in Social Studies[1]

2. Willis Moreland (ed.)--Social Studies in the Senior High School[2]

3. Richard Gross (ed.)--The Problems Approach and the Social Studies[3]

--The Problem-Solving Approach[4]

4. Lillian Logan--Social Studies: A Creative Direction[5]

5. Louis Hebert (ed.)--Structure in the Social Studies[6]

6. James High--Teaching Secondary School Social Studies[7]

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[1]Helen Carpenter (ed.), Skill Development in Social Studies, Thirty-Third Yearbook of the National Council for the Social Studies, 1963.

[2]Willis Moreland (ed.), Social Studies in the Senior High School; Programs for Grades Ten, Eleven, and Twelve, Curriculum Series, No. 7 (Washington: N.C.S.S., 1965).

[3]Richard Gross and others (eds.), The Problems Approach and the Social Studies, Curriculum series, No. 9 (Washington: N.C.S.S., 1960.

[4]Richard Gross and Frederick McDonald, "The Problem Solving Approach," Phi Delta Kappan, XXXIX (March, 1958), 295-65.

[5]Lillian M. Logan and Gerald T. Rimmington, Social Studies: A Creative Direction (Toronto: McGraw-Hill Company of Canada, 1969).

[6]Louis J. Hebert and William Murphy (eds.), Structure in the Social Studies (Washington: National Council for the Social Studies, 1968).

[7]James High, Teaching Secondary School Social Studies (New York: Wiley, 1962).

7. Dorothy Fraser--Social Studies in Secondary Schools: Curriculum and Methods[8]

8. Kopple Friedman--The Problem-Solving Approach to Economics in the Twelfth-Grade Problems Course[9]

9. William Hering--Social Science, History and Inductive Teaching[10]

10. Randall Anderson--Introducing the World Population Crisis to Secondary Social Studies Classes: An Inquiry-Oriented Instructional Strategy[11]

11. John Michaelis (ed.)--The Social Sciences; Foundations of the Social Studies[12]

--An Inquiry-Conceptual Theory of Social Studies Curriculum Planning[13]

12. Thomas Turner--Individualization Through Inquiry[14]

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[8]Dorothy McClure Fraser and Edith West, Social Studies in Secondary Schools: Curriculum and Methods (New York: Ronald Press Company, 1961).

[9]Kopple C. Friedman and William E. Miller, "The Problem-Solving Approach to Economics in the Twelfth-Grade Problems Course," Social Education, XXX (April, 1966), 276-78.

[10]William M. Hering, Jr., "Social Science, History, Inductive Teaching," Social Education, XXXII (January, 1968), 34-38.

[11]Randall Anderson, "Introducing the World Population Crises to Secondary Social Studies Classes: An Inquiry-Oriented Instructional Technique," Social Education, XXXIV (January, 1970), 27-35.

[12]John U. Michaelis and A. Montgomery Johnston (eds.), The Social Sciences; Foundations of the Social Studies (Boston: Allyn and Bacon, 1965).

[13]John U. Michaelis, "An Inquiry-Conceptual Theory of Social Studies Curriculum Planning," Social Education, XXXIV (January, 1970), 68-71.

[14]Thomas N. Turner, "Individualization Through Inquiry," Social Education, XXXIV (January, 1970), 72-73.

13. Shelley Koenigsberg--"'See and Suppose,' Learning Through Discovery in the Social Studies"[15]

CATEGORY II

1. Byron Massialas

(a) Inquiry in Social Studies[16]

In this, Massialas' most significant work, written in conjunction with Benjamin Cox, the following account respecting the hypothesis is outlined. In considering hypothesizing as the second step in reflective inquiry Massialas and Cox state (hereafter referred to as Massialas only):

> A hypothesis is formulated to serve as a general search model and to screen relevant from irrelevant data (F-1); the hypothesis links the initial problem to a body of theory (F-1). A hypothesis in order to be accepted, should satisfy the following basic criteria: (1) it should be testable (C-1), i.e., expressed in clear, precise, and sometimes quantitative language (C-3). (2) it should incorporate all the facts of the case under investigation and not just a few of them (O-2). (3) it should explain what it starts out to explain (F-4). (4) it should be simple (C-4) and have no internal contradictions (C-3).[17]

In defining an hypothesis Massialas then says this of it:

> . . . is the primary, declarative, general statement of explanation or solution (F-4); it expresses as clearly

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[15]Shelley P. Koenigsberg, "'See and Suppose,' Learning Through Discovery in the Social Studies," The Social Studies, CVII (November, 1966), 257-62.

[16]Byron Massialas and Benjamin Cox, Inquiry in Social Studies (New York: McGraw-Hill, 1966).

[17]Ibid., p. 332.

> as possible (C-3) the antecedent and consequent relationship, explanation (F-4), description, or policy which would apply to the social phenomenon under consideration. The hypothesis or hypotheses--alternative solutions are often hypothesized--represent research models which subsequently guide the students and teacher to relevant evidence (F-2). The hypothesis escapes the particular by restating the elements and relationships in general terms (F-1).[18]

In referring to its constitution or formulation he affirms,

> . . . that a sensitive interplay between the logical and the empirical exists in the process of reflection (O-2; O-4). While the support or proof of a hypothesis depends largely on empirical evidence (O-2), the careful examination of a statement requires exploration by means of certain logical tactics (O-4). In a sense, hypotheses are prepared for evidential support by means of logical exploration (O-4).[19]

In fact this really forms Massialas' third step in his "reflective inquiry," namely, <u>Exploration</u>:

> Whereas orientation and hypothesizing tend to be inductive in nature, this phase tends to be deductive (O-4). The hypothesis is more carefully explicated in terms of logical deductions and implications, and assumptions and premises (O-4). Qualifying and delimiting factors are more exactly spelt out (C-3). The finding of logically untenable grounds may cause a major reconstruction of the hypothesis at this time.[20]

Finally, in a more general discussion of the place of the hypothesis in reflective thought, he states:

> Furthermore, the scientist usually orders his work by means of a hypothesis--or a series of hypotheses (F-2)--which he sets out to prove or refute (C-6). That is, to begin his inquiry he states in the form of a working hypothesis what appears to be a plausible (C-7) explanation of solution to his problem (F-4). At this point of hypothesizing, the scientist calls into play

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[18]<u>Ibid</u>., p. 117.

[19]<u>Ibid</u>., pp. 66-67.

[20]<u>Ibid</u>., p. 118.

> some important logical skills (O-4. Primarily he uses logical constructions to extend his hypothesis toward needed evidence by means of the inferences and logical implications which he formulates (O-4; C-1). These constructions take the form of "if-then" statements (S-2), in which the hypothesis is restated as the "if" clause, while the "then" clause introduces the needed evidence (F-2). For example: If an enclosed measure of gas increases in volume as its temperature is raised than a partially filled balloon should become larger when heated. In this sense the hypothesis, "an enclosed measure of gas increases in volume as its temperature is raised," and its logical implication, "a partially filled balloon becomes larger when heated" (F-1), serve as a research model (F-2). This process guides the researcher into the selection of relevant cases, which will prove or disprove his original idea or hypothesis (F-2).[21]

"F-1" is inserted where it is because two levels of hypothesis are represented here. That is, both statements really constitute an hypothesis, one being only more "concrete" than the other. It should be pointed out as well that the use of the "if-then" clause is rather unusal here, since it is normally encompassed by the hypothesis itself.

Summary:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	4	C-1	2	O-1	0	S-1	0	
	F-2	5	C-2	0	O-2	3	S-2	1	
	F-3	0	C-3	4	O-3	0	S-3	0	
	F-4	4	C-4	1	O-4	7			
			C-5	0					
			C-6	1					
			C-7	1					
Cumulative total		13		9		10		1	33

[21]Ibid., p. 118.

Points					
total possible	3/4	5/7	2/4	1/3	11/18

Generally Massialas emphasizes function and two aspects of origin, barely touching on structure. He ignores the notion of predictability, but does stress the characteristic of simplicity and the logical nature of formulation.

(b) The Indiana Experiments in Inquiry: Social Studies[22]

First of all, in considering the ability to hypothesize as one of the "thinking habits" of critical thinking or problem-solving, Massialas writes:

> The individual shows an ability to hypothesize about these problems and to seek various courses of action or solutions to these problems (F-4).[23]

In suggesting the procedure actually employed by the student he claims that,

> This application of this theory in the classroom involved a problematic situation with which the student would be personally confronted and which he would try to resolve. The student's hunches or insights into the situation (O-3) offered certain possible solutions (F-4). These insights or hypotheses were fully developed and tested by bringing to bear upon them previously gained tested insights (O-1) and other available data (O-2).[24]

Then, concerning points relating to the hypothesis, in the lesson plan, using the problems approach he exhorts this sequence:

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[22]Byron Massialas, The Indiana Experiments in Inquiry: Social Studies (Indiana: Bureau of Educational Studies and Testing, School of Education, Indiana University, 1963).

[23]Ibid., p. 118.

[24]Ibid., pp. 1-2.

> The identification and clarification of a hypothesis (C-3); the drawing of logical implications in the form of "if-then" deductions (O-4). . . .[25]

In comparing methods of instruction Massialas describes problem-solving as entailing the construction of conceptualizations. These conceptualizations would concern the instigating problem and be derived from,

> . . . groups of descriptive but related facts (O-1). . . .[26]

Then he says that,

> The conceptualizations would take the form of insights or hypotheses with which the class would be confronted in order to explore their logical implications (O-4).[27]

Finally in regards to hypothesizing as a task he states that,

> . . . this task involved an imaginative projection (O-3) and explanation (F-4) of an undetermined situation with which the student was confronted.[28]

<u>Summary</u>:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	0	C-1	0	O-1	2	S-1	0	
	F-2	0	C-2	0	O-2	1	S-2	0	
	F-3	0	C-3	1	O-3	2	S-3	0	
	F-4	3	C-4	0	O-4	2			
			C-5	0					
			C-6	0					
			C-7	0					
Cumulative total		3		1		7		0	11

[25] Ibid., p. 9.

[26] Ibid., p. 4.

[27] Ibid., pp. 4-5.

[28] Ibid., p. 16.

Points total possible	1/4	1/7	4/4	0/3	6/18

In this selection Massialas virtually ignores function, characteristics, and structure, considering primarily origin. He does discuss all aspects of origin (schema) both in terms of basis and method of formulation. As well some attention is given to "explanation."

(c) A Reflective Model[29]

Again writing in collaboration with Cox, in a book edited by Rodney Allen, Massialas produces a definition of hypothesis identical to the one he outlines in his Inquiry in Social Studies. In the brief article, however, he does elaborate on certain elements in reference to testing criteria.

> . . . (2) its compatibility with previously devised generalizations and the experiences of the pupils and teacher (O-1), and (3) the existence of other historical facts and evidence which are relevant to its proof or disproof (O-1).[30]

Summary:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	1	C-1	0	O-1	2	S-1	0	
	F-2	1	C-2	0	O-2	0	S-2	0	
	F-3	0	C-3	1	O-3	0	S-3	0	
	F-4	2	C-4	0	O-4	0			

[29]Byron Massialas and Benjamin Cox, "A Reflective Model," Inquiry in the Social Studies; Theory and Examples for Classroom Teachers, eds., Rodney F. Allen, John V. Fleckenstein, and Peter M. Lyon (Washington: N.C.S.S., 1968).

[30]Ibid., p. 71.

		C-5 0			
		C-6 0			
		C-7 0			
Cumulative Total	4	1	2	0	7
Points total possible	3/4	1/7	1/4	0/3	5/18

In A Reflective Model, Massialas keys on the aspect of function, particularly the hypothesis as explanation. Here he neglects the other components with the exception of the point regarding the need for prior experience or knowledge.

(d) Creative Encounters in the Classroom; Teaching and Learning Through Discovery[31]

As a co-author with Jack Zevin in this book, Massialas reiterates some of his ideas on the hypothesizing process. He interprets parts three and four of Dewey's five-phase reflective thought process in this way:

> A working hypothesis is formulated during the third phase of the thinking process (which may or may not derive from the original suggestion) that places subsequent intellectual operations under control and leads to the collection and selection of additional data (F-2). The working hypothesis, in other words, serves as the search model that guides the solution of the problem (F-2; F-4). The fourth phase is the time when the mind relates ideas to one another and traces the logical implications of hypotheses (O-4).[32]

Massialas then again defines the notion of hypothesis, which in this case does, however, bring forth some new considerations.

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[31]Byron Massialas and Jack Zevin, Creative Encounters in the Classroom; Teaching and Learning Through Discovery (New York: Wiley, 1967).

[32]Ibid., p. 2.

> This is a statement of relationship between two or more events or phenomena (S-2). The hypothesis seeks to explain the problem or occurrence under consideration (F-4), but it escapes the particular by stating the nature of the relationship in general terms. The most important function of the hypothesis is to serve as a search model in collecting relevant information (F-2).[33]

At another point he declares that an hypothesis is,

> . . . a propositional statement about relations between variables or events (S-2). The hypothesis has a provisional status (C-6); when it is tested and confirmed, it becomes a generalization (F-1).[34]

<u>Summary</u>:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	1	C-1	0	O-1	0	S-1	0	
	F-2	3	C-2	0	O-2	0	S-2	2	
	F-3	3	C-3	0	O-3	0	S-3	0	
	F-4	2	C-4	0	O-4	1			
			C-5	0					
			C-6	1					
			C-7	0					
Cumulative total		6		1		1		2	10
<u>Points</u> total possible		3/4		1/7		1/4		1/3	6/18

In this book, Massialas, while ignoring characteristics and origin, does finally emphasize one aspect of structure, namely the necessity of a stated relationship. As well, Massialas stresses the guiding and explaining functions.

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[33] <u>Ibid</u>., pp. 7-8.

[34] <u>Ibid</u>., p. 266.

(e) Teaching Social Studies Through Discovery[35]

Massialas again teams up with Zevin in writing this article for Social Education. Discussed are the discovery and inquiry operations actually carried out by a group of students. One task involved,

> . . . formulating working hypotheses from the given data and their previous learning experiences (O-1), testing the hypothesis by drawing logical inferences (O-4) and by gathering relevant information (O-1). . . .[36]

They also note that,

> . . . speculative or "intuitive" thinking may be found, to a great or lesser degree, in all phases; when there is a gap in knowledge the student reaches out into unchartered and largely unknown realms of interpretation and thinking (O-3). From this observation the complementary nature of intuitive and analytic thinking may be seen (O-3; O-4).[37]

Summary:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	0	C-1	0	O-1	2	S-1	0	
	F-2	0	C-2	0	O-2	0	S-2	0	
	F-3	0	C-3	0	O-3	2	S-3	0	
	F-4	0	C-4	0	O-4	2			
			C-5	0					
			C-6	0					
			C-7	0					
Cumulative total		0		0		6		0	6
Points total possible		0/4		0/7		3/4		0/3	3/18

[35]Byron Massialas and Jack Zevin, "Teaching Social Studies Through Discovery," Social Education, XXVII (November, 1964), 384-87.

[36]Ibid., p. 387.

[37]Ibid.

In this work, Massialas talks only of origin, including all schema points for this component except for data from the problem situation.

(f) Teaching History as Inquiry[38]

Finally, Massialas is quoted from this paper, exposited as a chapter in a book entitled, The Social Studies; Structure; Models and Strategies and edited by Feldman and Seifman. Referring to hypotheses he writes,

> Obviously all do not have the same explanatory power (F-1; F-4); some are more valid than others, some are necessary causes; some are permissive conditions (F-4).[39]

Massialas goes on to say,

> Another very important aspect of the process of critical and analytic inquiry is definition. Unless both clauses of the hypothesis are expressed in operational, meaningful terms (C-3) the task of arriving at reasonable and valid conclusions (F-1) becomes formidable. Verifiability of a proposition depends both on content and communicability of meaning (C-3).[40]

Summary:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	2	C-1	0	O-1	0	S-1	0	
	F-2	0	C-2	0	O-2	0	S-2	0	
	F-3	0	C-3	2	O-3	0	S-3	0	
	F-4	2	C-4	0	O-4	0			

[38]Byron Massialas, "Teaching History as Inquiry," The Social Studies; Structure; Models and Strategies, eds., Martin Feldman and Eli Seifman (Englewood Cliffs, N.J.: Prentice Hall, 1969).

[39]Ibid., p. 232.

[40]Ibid., p. 233.

	Function	Characteristics	Origin	Structure	Composite Score
		C-5 0			
		C-6 0			
		C-7 0			
Cumulative total	4	2	0	0	6
Points total possible	2/4	1/7	0/4	0/3	3/18

Massialas, in Teaching History as Inquiry, looks at only three points: the functions of linking and explaining, and the criterion of clear statement.

Total for Massialas:

Components

	Function	Character-istics	Origin	Structure	Composite Score
	F-1 8	C-1 2	O-1 6	S-1 0	
	F-2 9	C-2 0	O-2 4	S-2 3	
	F-3 0	C-3 8	O-3 4	S-3 0	
	F-4 13	C-4 1	O-4 12		
		C-5 0			
		C-6 2			
		C-7 1			
Cumulative total	30	14	26	3	73
Points total possible	3/4	5/7	4/4	1/3	13/18

In all, Massialas covers most of the schema points, but is definitely weakest in the area of structure. Special emphasis is placed on the linking, guiding, and explaining functions; the criterion of clear statement; and the need for systematic inference in originating.

2. Maurice Hunt--Teaching High School Social Studies[41]

Hunt and Metcalf (hereafter referred to as Hunt only)

[41]Maurice P. Hunt and Lawrence E. Metcalf, Teaching High School Social Studies (New York: Harper and Row, 1968).

in this book present the following analysis. As is customary a definition is initially provided.

> A hypothesis is a statement of an anticipated solution to a problem (F-4), so phrased as to be verifiable (C-1). Implicit in it is an if-then relationship (S-2).[42]

The nature of an hypothesis as determined by one of its functions is then discussed. In reference to the hypothisis' role of problem (indeterminate situation) enlightenment Hunt states,

> This rather complex problem cannot be solved without recourse to a number of previously verified insights (O-1). Let us grant that it is original (O-3). . . . Even so, there must be a particular conceptual background on which to draw (O-1); otherwise he would not be able to imagine such an explanation (O-3). He has generalized experiences (O-1). . . .[43]

He then speaks of the "Complete Act of Thought" in the "Reflective Method." The pertinent stages are reproduced:

> (2) Formulation of hypotheses
> (3) Elaboration of logical implications of hypotheses (O-4). This includes deducing observations which have already been made--so that hypotheses may be checked against present knowledge (O-1); and deducing observations which have not already been made so that hypotheses may be tested through experimentation (O-4).[44]

Probably making reference to the same requirement of elaboration it is held that,

> Clarifying and defining hypotheses is often a lengthy procedure, but it is absolutely necessary if thought is to go forward at all (C-3; O-4).[45]

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[42] Ibid., p. 28.

[43] Ibid., p. 35.

[44] Ibid., p. 60.

[45] Ibid., pp. 116-17.

And at another point,

> Statements which contain high-order abstractions usually require very careful definition before they can serve as hypotheses (C-3). . . . Of the various kinds of definition, the one of the greatest significance in scientific methodology is the operational definition. An operational definition describes an object or process in use (C-1; O-4).[46]

Hunt then considers another requirement:

> As scientific method is now conceived, any statement which is meant to serve as a hypothesis must be verifiable--that is, subject to the test of empirical evidence. When used in this connection, the term verifiable means testable--capable of being shown either true or false. The verifiability of a statement hinges on both its content and the way in which it is phrased (C-1.[47]

He, as well, attempts to distinguish judgements of fact from value judgements. Only the former is considered "scientifically legitimate." He declares,

> In the present book, by judgement of fact we shall mean statements about observable and measurable qualities (C-1), from which we may derive if-then relationships (C-2) open to scientific tests (C-1).[48]

Consequently follows another statement made in the same context:

> It is often argued that only judgements of fact may serve as hypotheses in any investigation which purports to be scientific. A preference (value judgement), it is held, can never be shown to be true or false on the basis of public evidence (C-1). . . .[49]

Hunt then repeats the primary requirement that qualifies this

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[46]Ibid., p. 70.

[47]Ibid., p. 68.

[48]Ibid., p. 75.

[49]Ibid., p. 72.

type of statement as a bonafide hypothesis.

> Apparently any statement whose truth may be tested by scientific means, any statement which may be shown through public tests to be true or false, may function as a hypothesis (C-1.[50]

The debatable question, however, according to Hunt, seems to be,

> . . . whether the proposition may be defined meaningfully (that is, operationally) in a way acceptable to all investigators (C-3).[51]

The close association between "C-1" and "C-3" and the prerequisite nature of "C-3" is accentuated here,

> The verifiability of many statements . . . appears to hinge on whether general agreement on the meaning of all terms may be secured.[52]

Other features of hypothesis may be isolated from Hunt's account.

> Judgements of fact are statements which describe relationships between things (S-2). They are objective; i.e., they have assumed referents in nature (S-3). The grounds for a judgement of fact always lie in observations or experiments (O-2). They are testable with public evidence (C-1); that is, any investigator may verify them. . . . A judgement of fact may or may not be true (C-5). Its distinctive quality depends not on it being true but on the supposition that its truth can be checked objectively (C-1).[53]

Another important function is revealed by the following statement:

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[50]Ibid., p. 73.

[51]Ibid.

[52]Ibid.

[53]Ibid., p. 71.

> A hypothesis is useful only if it brings order to the obtainable data--perhaps not perfect order, but a large measure of order (F-2).[54]

Hunt reveals the necessity of logical reduction, actually, while unaware, demonstrating levels of hypothesis. The example of reduction provided is shown here:

> Problem: What are some possible explanations of the present rise in the rate of juvenile delinquency in the United States?
>
> Hypothesis: The increasing use of automobiles by teen-agers in the United States contributes to the rise in the rate of delinquency.
>
> Deduction: If the use of autos contributes to delinquency, then we should find more auto users among delinquents than among non-delinquents (F-1; O-1; O-4).[55]

On the basis of the analysis of Chapter 2, deduction here merely modifies the more abstract statement into a more concrete, testable form. Thus <u>both</u> statements represent hypotheses, the second actually being more characteristic of "true" hypothetical form, possessing the "if-then" clause as it does (S-2). Perhaps the first statement could be considered a "conceptual" hypothesis; the latter an "operational" one. Referring to the structure of the latter statement Hunt has this to say:

> The "if-clause" (antecedent) is a brief statement of the hypothesis itself. The "then-clause" (consequent) states a fact which should be true if the hypothesis is true. A deduction is a good one if the truth of the then-clause is warranted by the truth of the if-clause. . . . The then-clause follows directly and logically from the if-clause (O-4).[56]

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[54] <u>Ibid</u>., p. 86.

[55] <u>Ibid</u>., p. 80.

[56] <u>Ibid</u>.

The "if" and "then" clauses are again used in a different sense than is customary. Here they are considered to involve separate statements, separate hypotheses; not simply elements of the same hypothesis. Hence, the deduction spoken of is unusual. When limited to the confines of the hypothesis itself, this requirement is really closer to "C-3."

As a result of this erroneous use of the if-then clause the following statement does not really entail "S-3" as it may appear to. Hunt states that,

> As a general rule, the then-clause of a deduction should refer to the same situation or group of cases to which the if-clause refers (S-3).[57]

That Hunt is really only calling for logical, consistent deduction is indicated by his summary statement:

> The results of inquiry are no better than the quality of deductions made from hypotheses (O-4).[58]

To conclude his discussion of hypothesis Hunt asks some rather key questions in reference to the capacity of students to carry out some of the operations entailed in hypothesizing:

> . . . are students able to use simple principles of logic in reaching a conclusion (O-4)?
> . . . are they familiar with the simple rules of evidence (O-2) and the characteristics of a hypothesis? [some implication, but no provision]
> . . . do they know what a theory is and how it is different from a hypothesis (F-1; O-1)?[59]

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[57]Ibid., p. 82.

[58]Ibid.

[59]Ibid., p. 429.

Summary:

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	2	C-1	9	O-1	6	S-1	0	
	F-2	1	C-2	1	O-2	2	S-2	2	
	F-3	0	C-3	3	O-3	1	S-3	2	
	F-4	1	C-4	0	O-4	7			
			C-5	1					
			C-6	0					
			C-7	0					
Cumulative total		4		14		16		4	38
Points total possible		3/4		4/7		4/4		2/3	13/18

Hunt in his publication carries out a fairly comprehensive analysis of all four major components. He has more to say about structure than any one of the other writers analyzed. He touches least upon function, hitting hard upon the characteristic of testability, and the knowledge base and logic of formulation.

3. Bernice Goldmark--Social Studies; A Method of Inquiry[60]

Goldmark considers the "abduction" of alternative hypotheses to be the second step in the inquiry process. Quoting her,

> At this stage we entertain hypotheses. . . . The range of possible alternative hypotheses depends upon (1) the context of the situation (O-2) and (2) the conceptual scheme of the inquirer (O-1).
>
> Those hypotheses that we do entertain are held, even if just for a brief moment, as ideas (C-6). That is, they are held symbolically while we make further

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[60]Bernice Goldmark, Social Studies; A Method of Inquiry (Belmont, Calif.: Wadsworth, 1968).

> symbol relations (O-4), which we call predictions (F-3). On the basis of the probability of our prediction, we accept or reject a hypothesis (C-7).
>
> The idea which we entertain as a conjecture is operational. It operates as an instigator and director (F-2) of further operations of observation (F-1), organization (F-2), and prediction (F-3).[61]

Of the third step, gathering data, Goldmark has this to say,

> This idea or hypothesis, that we entertain directs our search for data (F-2). . . . Facts are only facts when they are inquired into. They are determined by the hypothesis (F-2). If we do not hypothesize them, they do not become subject matter until inquiry is brought to bear on it.[62]

Elaboration of this function can be noted in "step four" which she calls the Analyzing of Alternative Hypotheses:

> Although organization of the data begins at the same time as the gathering of the data (the limitations imposed by the hypothesis effect some organizational pattern) (F-2), data is also organized after it is gathered, so that systematic analysis and judgements can be brought to bear on it (F-2). . . .
>
> The organizational operation is in the form of a means-ends analysis. An "if . . . then . . ." prediction (F-3) is made with each hypothesis. "If it is a bird, then a, b, c will be found" (S-2). "If it is an insect, then x, y, z will be found." When we find data a, b, c, our prediction is regarded as true. It will be noted that the end--the conclusion that it is a bird--is contained in the hypothesis (F-3; F-4). The data a, b, c become the means to our predicted end (O-2), which we now accept as the "probably true conclusion" (C-5).[63]

In "step six," Identifying the Values and Assumptions, Goldmark actually mentions various bases for, or sources of, hypotheses as she deals with the means of evaluating validity

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[61] Ibid., p. 116.

[62] Ibid., pp. 116-17.

[63] Ibid., p. 117.

or judging the "objective" worth of the hypothesis. She states that what is valued is evidence (O-2), but that,

> It is also possible for the judgement to be made on the basis of intuition (O-3), a feeling that it was a bird, or on the basis of authority (O-1); someone said it was a bird. But in both cases something other than evidence is valued.[64]

At another point it is held that,

> . . . children must develop skill in organizing the data into means-end-method categories of each alternative (F-3; F-4). When we identify the possible alternative solutions (F-4) to a problem--the options from which we can choose--we pose each alternative as a hypothesis, as an "if" statement (S-2).[65]

She states a little later that,

> Our next step, after gathering hypotheses, is to predict from the hypothesis (F-3).[66]

But surely, as she has already indicated, prediction is already involved in stating hypotheses; that is, they include both "if" and "then" sectors. Thus, even though the following exposition implies distinct phases, it seems evident that Goldmark seems to encompass the whole sequence in the hypothesizing process ("means-end-method categories of each alternative"). She continues,

> Our then propositions can be organized according to the end predicted and the means and method for achieving the end (F-3; F-4). . . . What we have said is "if we choose this alternative, then these things would have to happen (means) in this way (method) to produce this result (end).[67]

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[64] Ibid., p. 118.

[65] Ibid., p. 43.

[66] Ibid., p. 43.

[67] Ibid.

An important aspect of the scientific attitude is supplied at another stage:

> Truth is held as a temporary hypothesis (C-6), subject to revision as ends, means, and methods are revised. The truth of any hypothesis can never be proven absolutely (C-5).[68]

Goldmark sums up her "position" on hypothesis formation in this way:

> Although this kind of analysis involves prediction [italics in the original] (F-3) of what might happen and how it might happen (C-5), the prediction is based on intelligent method--that is, on the gathering and organizing of data (F-2; O-2) and the relating of the means-end-method of the hypothesis.[69]

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	1	C-1	0	O-1	2	S-1	0	
	F-2	7	C-2	0	O-2	4	S-2	2	
	F-3	8	C-3	0	O-3	0	S-3	0	
	F-4	4	C-4	0	O-4	1			
			C-5	3					
			C-6	2					
			C-7	1					
Cumulative total		20		6		8		2	36
Points total possible		4/4		3/7		4/4		1/3	12/18

Goldmark concentrates on function and origin with relatively less on characteristics and structure. All functions, but the linking one, are well explicated, while the necessity of logical reasoning receives the most thorough

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[68] Ibid., p. 68.

[69] Ibid., p. 145.

treatment of those in the origin component.

4. Charlotte Crabtree

(a) Supporting Reflective Thinking in the Classroom[70]

In this chapter of the 37th Yearbook of N.C.S.S., Crabtree begins her discussion of hypothesis in this way:

> Inquiry is not conducted as an indiscriminate search for facts; it is, instead, an organized, directed search. Hypotheses direct its activities (F-2). These hypotheses, in turn are the consequence of the conceptual principle or theory on which the inquiry is first conceived (O-1). Hypotheses determine what facts will be selected as relevant to the problem (F-2). They influence what interpretations are formulated and accepted in the end.[71]

She then deals with the basis for "hypothetical thinking" in pronouncing that "precision," a phase of education posited by Alfred North Whitehead,

> . . . is preceded in inquiry processes by a stage of hypothetical thinking and "open" search (O-3). Old ideas are rearranged, pondered for new meanings, "thrown into fresh combinations." In this stage, imagination (O-3) and the power to structure new relationships (O-4) are called into play.[72]

She exhorts, that to accomplish this task, the students be free to,

> . . . engage in a search for hypotheses that restructure present ways of viewing the situation (O-4).[73]

Continuing to deal with the aspect of formulation and

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[70]Charlotte Crabtree, "Supporting Reflective Thinking in the Classroom," Effective Thinking in the Social Studies, 37th Yearbook of the National Council for the Social Studies, eds., Jean Fair and Fannie Shaftel (Washington: N.C.S.S., 1967).

[71]Ibid., p. 89.

[72]Ibid., p. 100.

[73]Ibid., p. 101.

development Crabtree talks of,

> Extending the hypothesis toward its logical consequences (O-4). . . . If classroom inquiries require a time for open exploration and inventive thinking, they also require a time for rigorous test and analysis (C-1; O-4). Hypotheses purporting to explain (F-4) an event are tested against the reliability of the conclusions they predict [F-3]. . . . [This involves] . . . helping students to state the facts (O-2) on which the hypothesis rests, and to propose the logical extension of the hypothesis in order to test its reliability (C-1; O-4).[74]

She then proceeds to describe this "extension" process:

> Deducing the consequences of hypotheses in order to test them experimentally (C-1; O-4) is an important phase of experimental method. . . . To derive valid conclusions from hypotheses requires students to follow the rules of deductive logic (O-4).[75]

In relation to a function previously referred to Crabtree states,

> In marshalling the data for testing an hypothesis, the researcher uses the hypothesis as the focus of his search (F-2). Hypotheses establish which facts are relevant, and, once obtained, the categories into which those facts will be ordered (F-2). Developing systems of classifying data involves the logical operations of establishing relevant, clearly defined (C-3), and mutually exclusive categories (F-2; O-4).[76]

The inductive reasoning process is next described,

> Induction is the process by which "propositions of unrestricted generality" are asserted on the basis of particular instances. It is the process by which generalizations are inferred, on reasoned consideration of particular facts (O-4).[77]

In connection with this operation of inference, Crabtree

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[74] *Ibid.*, pp. 101-02.

[75] *Ibid.*, p. 103.

[76] *Ibid.*, p. 105.

[77] *Ibid.*, p. 106.

stipulates that to increase its reliability (could be interpreted to include plausibility and probability),

> . . . it is necessary to maintain precise methods of observation, to increase objectivity, and to base the premise on verifiable evidence (O-2) which can be publicly corroborated. Generally, the inference which best accounts for the data obtained (O-2), and which is consistent with existing reliable knowledge (O-1) is accepted as a reliable statement. It is, of course, open to continuing inquiry and subsequent change (C-6).[78]

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	0	C-1	3	O-1	2	S-1	0	
	F-2	5	C-2	0	O-2	3	S-2	0	
	F-3	1	C-3	1	O-3	2	S-3	0	
	F-4	1	C-4	0	O-4	9			
			C-5	0					
			C-6	1					
			C-7	0					
Cumulative total		7		5		16		0	28
Points total possible		3/4		3/7		4/4		0/3	10/18

Crabtree, in Supporting Reflective Thinking in the Classroom, produces a fair coverage of three of the four components. Structure is entirely neglected. Origin, particularly the requirement of logical reasoning, is discussed most extensively. The guiding or directing function is also well stressed.

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[78] Ibid., p. 107.

(b) Inquiry Approaches: How New and How Valuable?[79]

In this paper Crabtree writes of the problems sequence, which she examines, that it,

> . . . requires processes in creative thinking (O-3)--in the structuring of new hypotheses or generalizations, for example--and processes of rigorous test and experimentation. These are processes differentiated by divergent and convergent thinking (O-4); by the production or creative exploration of new (O-3), or tentative (C-6) ideas, for example; and, by the recall of knowledge already acquired (O-1), and the derivation of conclusions logically following from pre-established conditions (O-4).
>
> Both operations are important to productive thinking. Both contribute to problems resolution (F-4) and to the verification and extension of knowledge (F-1).[80]

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	1	C-1	0	O-1	1	S-1	0	
	F-2	0	C-2	0	O-2	0	S-2	0	
	F-3	0	C-3	0	O-3	2	S-3	0	
	F-4	1	C-4	0	O-4	2			
			C-5	0					
			C-6	1					
			C-7	0					
Cumulative total		2		1		5		0	8
Points total possible		2/4		1/7		3/4		0/3	6/18

In this production Crabtree touches on only a limited number of points, with, nevertheless, obvious attention to function, considering especially prediction and explanation.

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[79] Charlotte A. Crabtree, "Inquiry Approaches: How New and How Valuable?" Social Education, XXX (November, 1966), 523-25.

[80] Ibid., p. 525.

Total for Crabtree:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	1	C-1	3	O-1	3	S-1	0	
	F-2	5	C-2	0	O-2	3	S-2	0	
	F-3	1	C-3	1	O-3	4	S-3	0	
	F-4	2	C-4	0	O-4	11			
			C-5	0					
			C-6	2					
			C-7	0					
Cumulative total		9		6		21		0	36
Points total possible		4/4		3/7		4/4		0/3	11/18

In analyzing Crabtree's contributions it is noted that structure receives no treatment. Coverage on characteristics is mediocre. Origin is treated most thoroughly, the most frequent target being the notion of systematic inference. Of the functions alluded to, the guiding or directing one is most stressed.

5. Sociological Resources for the Social Studies[81]

Departing slightly from the format of this analysis, a joint project, rather than that of a single writer, will be evaluated. The relevant kit or unit is entitled, Testing for Truth: A Study of Hypothesis Evaluation.

The discussion of hypothesis in the main pamphlet relates to some aspects of the schema. First of all, the hypothesis is defined as,

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[81] Sociological Resources for the Social Studies, Testing for Truth: A Study of Hypothesis Evaluation, Episodes in Social Inquiry Series (Boston: Allyn and Bacon Ltd., 1969).

> . . . a preliminary (C-2) but useful statement of a possible, plausible (C-7) conclusion (F-4).[82]

Then in elaboration on this statement the following is stated,

> When you state a hypothesis, you're anticipating what some of the results might be (F-3). It is a preliminary statement because you adopt it long before you start to gather data (C-2). It is also preliminary in the sense of being tentative or untried (C-6). The evidence may later show that you have to reject it altogether or modify it considerably (O-2). . . . hypotheses state conclusions that might be reached after gathering actual evidence (C-5; C-6). On the basis of a general argument (O-1), a hypothesis predicts what the researcher expects to find in a particular case (F-3).[83]

The Instructor's Guide, as well, exposits on the subject. Hypotheses are defined as,

> . . . tentative (C-6) predictions (F-3) whose accuracy is to be checked by gathering and analyzing appropriate data (O-2).[84]

The guide is probably considering, what is in this study being termed the unsystematic variety of hypothesis, when it makes reference to,

> . . . hypotheses of a very crude sort . . . [having] . . . the makings of a hypothesis, however "ill-founded."[85]

It is then held that the hypotheses students employ in research should differ from thin "unstructured" hypothesis in several ways:

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[82] Ibid., p. 3.

[83] Ibid.

[84] Ibid., p. 13.

[85] Ibid.

> First, they will be tested (C-1) on samples drawn to reflect with measurable accuracy the attitudes of the entire group or population (O-1). Second, they will be stated in such a way that they can be tested. (The hypothesis so muddily stated (C-3) that it can't be tested is useless to the sociologist) (C-1).
>
> Finally, the hypothesis will be plausible (C-7). They must be based on reasonable or rational assumptions (C-7; O-4). This is what the word "hypothesis" means . . . the word hypothesis means literally "under the theses"--i.e., derived from a broader thesis or principle (F-1; O-1). It is a statement that tells us what sort of connection we should expect between two variables in a particular case (S-2), provided some more general principle (the thesis) is correct.[86]

In further connection with formulation or origin, the guide, in recognizing other problems, demonstrates an extensive awareness of certain features.

> There are plenty of hypotheses that can be formulated about any given theme. Students should be given an opportunity to be creative in formulating interesting hypotheses (O-3). . . . You . . . [the teacher] . . . will have to help at two points in particular: (1) making the hypothesis a precise (C-3) and testable (C-1) statement, and (2) seeing to it that there is a plausibly (C-7) if not persuasive, underlying argument, from which the hypothesis is derived (O-4). Discourage student suggestions that are not based on reason (O-4), that are off the top of their heads.[87]

Perhaps the latter statement may appear to be somewhat of a contradiction with "O-3," connoted by Dewey's expression, "popping into the head." But in fact it is really not, since even Dewey demanded prior knowledge and logic (reasoning). Thus that idea that "pops" is really only as good as the source and basic reasoning process from which it "popped."

The guide continues, really reiterating that declared

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[86] Ibid.

[87] Ibid., p. 16.

by the main pamphlet:

> In a way, the statement of a hypothesis is a prediction (F-3). The hypothesis states that under certain conditions a given variable like sex or age will enable us to predict likely responses (F-2; S-3). We can make such a prediction with some confidence only if students have worked through a good reasoning process that leads to the hypothesis (O-4).[88]

A couple of other unique characteristics, seldom emphasized, are brought out as well. Firstly, the teacher is admonished:

> Be sure your students understand that it be just as valuable to refute as to confirm a hypothesis (C-5).[89]

Secondly, a very real but neglected point is introduced,

> Another matter that you should be aware of is that a hypothesis always assumes that, "other things being equal."[90]

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	1	C-1	3	O-1	3	S-1	0	
	F-2	0	C-2	2	O-2	2	S-2	2	
	F-3	5	C-3	2	O-3	1	S-3	0	
	F-4	1	C-4	0	O-4	4			
			C-5	2					
			C-6	3					
			C-7	3					
Cumulative total		7		15		10		2	34
Points total possible		3/4		6/7		4/4		1/3	14/18

The S.R.S.S. provides one of the more comprehensive

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[88] Ibid.

[89] Ibid.

[90] Ibid.

coverages of the concept, hypothesis. However, as proven to be a common shortcoming, little is said of structure: only the requirement of "relationship" is considered. Fairly even treatment is given to the other components, with special emphasis on the predicting function and the inference aspect of origin.

6. <u>David Kellum--The Social Studies; Myths and Realities</u>[91]

Kellum begins by identifying one skill objective:

> To develop the faculty of formulating hypotheses on the basis of observation that would explain the phenomena (O-2).[92]

This capability would involve the ability to,

> . . . generalize or to form hypotheses or assumptions on the basis of the accumulated evidence (O-2; O-4).[93]

Kellum then claims that,

> It is important that the teacher emphasize the rules for forming valid assumptions: that the assumption be based upon sufficient evidence, that there be no outstanding body of evidence tending to impeach or contradict the assumption (O-1; O-2), and that the assumption be drawn validly from the evidence at hand without undergoing any unwarranted expansion of meaning or application (O-4). The teacher will wisely take the time to distinguish between the distinct qualities of "truth" and "validity" in assumptions, eliciting from the class examples of hypotheses that are "valid" but not "true," and "true" but not "valid" (C-5; C-7) it is likewise important to demonstrate that reliability is contingent upon both.[94]

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[91]David F. Kellum, <u>The Social Studies; Myths and Realities</u> (New York: Sheed and Ward, 1969).

[92]<u>Ibid</u>., p. 53.

[93]<u>Ibid</u>.

[94]<u>Ibid</u>., p. 56.

By this last statement Kellum probably means generalizability to like conditions; the capacity to attain the status of a generalization or law. To accomplish this an hypothesis must be more than just valid (logically derived and consistent); it must be true as well. Yet a "non-true" hypothesis may be just as _instrumental_ as a true one; and since the main purpose of a hypothesis is to serve as a tool, this capacity of "validity" is normally deemed sufficient.

Kellum then goes on to deal with the actual process of formation.

> After some practice in observing and classifying what is observed (F-2), the teacher might next introduce the process of deductive thinking or drawing inferences from our observations (O-4).
>
> . . . the mind leaps naturally to the hypothesis even from a single observation (o-3). The hypothesis of generalization is among the most formidable of the teacher's weapons because it serves two uses. It is, first, a station at which we can recoup; at which we can collect and organize our observations and inferences (F-2), thus renewing our sense of direction (F-2) and our courage. Second, a hypothesis by its very nature seduces man into a renewal of the struggle. It is not an answer (contradicts F-4). It is an explanation for what we have observed (F-4)--still very much a question (C-6). It is not yet either right or wrong (C-6). . . . With the creation of the hypothesis, right or wrong, the student has now hurtled beyond the perimeter of what is known (F-1; O-3).
>
> . . . Most of our hypotheses are yielded by the process of induction, that is, reasoning from a number of particular instances to a general truth (O-4).[95]

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[95] _Ibid._, pp. 109-19.

Summary:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	1	C-1	0	O-1	1	S-1	0	
	F-2	3	C-2	0	O-2	3	S-2	0	
	F-3	0	C-3	0	O-3	2	S-3	0	
	F-4	1	C-4	0	O-4	4			
			C-5	1					
			C-6	2					
			C-7	1					
Cumulative total		5		4		10		0	19
Points total possible		3/4		3/7		4/4		0/3	10/18

Kellum in this book has little to say of characteristics or criterion and nothing at all of structure. He is most concerned with origin, but does stress the guiding and directing function.

7. Edwin Fenton

(a) The New Social Studies[96]

In this, his major work, Fenton begins by defining hypotheses as,

> . . . tentative explanations adopted provisionally (C-6) to explain certain facts (F-4) and guide the investigation of others (F-2). . . .[97]

He also talks of the need to,

> . . . learn the rules of logic which govern the process (O-4).[98]

Fenton speaks extensively of the structure and method

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[96]Edwin Fenton, The New Social Studies (New York: Holt, Rinehart and Winston, 1967).

[97]Ibid., p. 11.

[98]Ibid.

of the social science disciplines that form the basis for the social studies. He holds that structure incorporates both "a body of imposed conceptions" and the procedure or methodology. So in this connection he points out that the "hypothesis-making" aspect of structure is normally associated with concepts, but that,

> A few projects identify the hypothesis forming part of structure with analytical questions.[99]

In demonstrating the application of such questions he purports that they,

> . . . help historians to bring order to data (F-2) as they think about the past. What they take down in notes will be governed largely by the questions they put to the documents they consult.[100]

Whether or not concepts or analytical questions can be attributed the cricial role that Fenton awards them, the following passage does reveal his regard for a significant role of hypotheses:

> Structure considered as either concepts or analytical questions plays a central role in inquiry. Structure leads to hypotheses. Someone who understands the concept of leadership or knows how to ask analytical questions about leaders may well interpret data differently from a person unacquainted with the idea (F-2). . . . structure influences the hypotheses one can develop (O-1) and hence controls inquiry (F-2).[101]

He shows his appreciation for a source or basis of hypotheses, in discussing what students will need:

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[99]Ibid., p. 14.

[100]Ibid.

[101]Ibid.

> In order to inquire without cues from the teacher, they must have honed their critical thinking skills to a fine edge (O-4) and amassed an impressive body of knowledge (O-1) to trigger and test hypotheses.[102]

Fenton then further admonishes the teacher on the subject of hypothesis formulation and testing.

> . . . encourage students to examine the logic of their thinking (O-4) by the sorts of questions he asks: Are you assuming something? Is your definition adequate? Does your conclusion necessarily follow? Questions like these help students develop skills which are essential to the accurate evaluation of hypotheses (O-4).[103]

Summary:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	0	C-1	0	O-1	0	S-1	0	
	F-2	4	C-2	0	O-2	2	S-2	0	
	F-3	0	C-3	0	O-3	0	S-3	0	
	F-4	1	C-4	0	O-4	4			
			C-5	0					
			C-6	1					
			C-7	0					
Cumulative total		5		1		6		0	12
Points total possible		2/4		1/7		2/4		0/3	5/18

In this book Fenton keys on the function of guiding research and the point of systematic inference. No mention is made of structure, with virtually no mention of characteristics.

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[102] Ibid.

[103] Ibid.

(b) Teaching the New Social Studies in Secondary Schools[104]

Here Fenton just sketches the procedure customarily employed by the historian:

> How does a historian start to select? He usually starts with a question. . . . Then he begins to do research, reading, and collecting notes about his topic. Before long he starts to develop a hypothesis, a tentative answer to the question (F-4; C-6). As he gathers more data, he revises his hypothesis; he may abandon it entirely if he finds enough evidence against it (O-2). In this case, he will be forced to develop another hypothesis to guide his research (F-2). Eventually he will conclude that the hypothesis he has developed really explains the facts of the case (F-4).[105]

Summary:

	Components								
	Function		Characteristics		Origin		Structure		Composite Score
	F-1	0	C-1	0	O-1	0	S-1	0	
	F-2	1	C-2	0	O-2	1	S-2	0	
	F-3	0	C-3	0	O-3	0	S-3	0	
	F-4	2	C-4	0	O-4	0			
			C-5	0					
			C-6	1					
			C-7	0					
Cumulative total		3		1		1		0	5
Points total possible		2/4		1/7		1/4		0/3	4/18

In this publication Fenton merely mentions the guiding and explaining functions, the characteristic of tentativeness, and the origin point of basis in subject matter.

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[104]Edwin Fenton, Teaching the New Social Studies in Secondary Schools (New York: Holt, Rinehart and Winston, 1966).

[105]Ibid., p. 53.

(c) Developing Inquiry Skills With an Experimental Social Studies Curriculum[106]

For this contribution to the Journal of Educational Research, Fenton teams up with John Good and John Farley. For the subject of hypotheses these authors borrow from another paper written by Fenton and Good.[107] Fenton and the others refer to the 6-step mode of inquiry for the social studies adopted by the Carnegie group, of which two steps relate to hypothesizing:

Step 2: Formulating hypotheses
--asking analytical questions
--stating hypotheses
--remaining aware of the tentative nature of hypotheses (C-6).

Step 3: Recognizing the logical implications of hypotheses (F-1; O-4).[108]

A skill objective is included:

> To make a hypothesis . . . the students develop a number of questions based upon social science concepts (O-1).[109]

So, Fenton and the others conclude, it is important to,

> . . . encourage the students to develop hypotheses from the data (O-2) by answering questions derived from social science concepts (O-1).[110]

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[106] John M. Good, John U. Farley, and Edwin Fenton (Carnegie--Mellon University), "Developing Inquiry Skills With an Experimental Social Studies Curriculum." Journal of Educational Research, CXIII (September, 1969), 31-35.

[107] Edwin Fenton and John Good, "Project Social Studies: A Progress Report." Social Education, XXIX, No. 4, (April, 1965), 206-08.

[108] Ibid., p. 32.

[109] Ibid., p. 33.

[110] Ibid.

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	1	C-1	0	O-1	2	S-1	0	
	F-2	0	C-2	0	O-2	1	S-2	0	
	F-3	0	C-3	0	O-3	0	S-3	0	
	F-4	0	C-4	0	O-4	1			
			C-5	0					
			C-6	1					
			C-7	0					
Cumulative total		1		1		4		0	6
Points total possible		1/4		1/7		3/4		0/3	5/18

Fenton, in this book does emphasize the component of origin, omitting only the imagination factor. However, respecting the other components, he only regards two other points: the linking function and the tentative criterion.

Total for Fenton:

Component

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	1	C-1	0	O-1	2	S-1	0	
	F-2	4	C-2	0	O-2	4	S-2	0	
	F-3	0	C-3	0	O-3	0	S-3	0	
	F-4	3	C-4	0	O-4	5			
			C-5	0					
			C-6	3					
			C-7	0					
Cumulative total		8		3		11		0	23
Points total possible		3/4		1/7		3/4		0/3	7/18

Fenton, in all his productions pays but little attention to characteristics and none to structure. He does, though, respecting the other two components, deal with all

the schema points but the purpose of prediction and basis in the imagination.

8. Hilda Taba--Implementing Thinking as an Objective in Social Studies[111]

Taba, in this chapter also written for N.C.S.S., has the following to say of the steps involved in hypothesis development:

> The third operation is formulating generalizations or inferences (O-4) by using the processed data (O-2), but going beyond that which is given (O-3). . . .
> . . . .
> . . . Discovery of generalizations and inferring (O-4) is essentially a creative, productive and innovative process (O-3). . . .
> . . . .
> . . . The third cognitive task is applying what one knows--facts and generalizations (O-1)--in order to explain new phenomena (F-4; O-2), to predict (C-3) consequences from known phenomena or to make hypotheses about causes and consequences (F-4), to build theories (F-1).[112]

It is to be noted that Taba actually separates predicting from hypothesizing. Of course, hypothesizing is necessarily a type of prediction. However, resolution may be found in the fact that the prediction Taba is concerned with might be closer to the idea of clarifying implications for testing; a necessary logical extension of the hypothesis. Her separation is perhaps even more pronounced in the following passage:

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[111] Hilda Taba, "Implementing Thinking as an Objective in Social Studies," Effective Thinking in the Social Studies, 37th Yearbook of the National Council for the Social Studies, eds., Jean Fair and Fannie Shaftel (Washington: N.C.S.S., 1967).

[112] Ibid., pp. 37-38.

> At times some already identified solution is to be applied, its consequences predicted. At other times some generalization must be retrieved or developed out of what is already known (O-1), and held as an hypothesis which may be established with reasons (O-4) as a proper explanation, conclusion, or consequence (F-4).[113]

Taba's sequence of hypothesis formulation may be best revealed by the list of accompanying mental operations which she provides,

> (1) Retrieving relevant knowledge (O-1; O-2).
> (2) Determining the causal links leading to prediction or hypothesis (O-4).
> (3) Using logical methods (O-4) or factual knowledge (O-1) to determine necessary and sufficient conditions (C-1).[114]

She points out as well that hypothesizing requires, depending on the nature of the problem, either divergent or convergent thinking, or some combination of the two (O-4). But of divergent, creative thought she qualifies that,

> . . . even in such cases distinctions need to be made between student responses which are completely unconstrained by realities and data (O-3) and those whose novelty or divergences are the result of a novel interpretation or combinations of reality (O-2; O-3; O-4).[115]

Summary:

Components

Function		Character-istics		Origin		Structure		Composite Score
F-1	1	C-1	1	O-1	4	S-1	0	
F-2	0	C-2	0	O-2	4	S-2	0	
F-3	0	C-3	1	O-3	4	S-3	0	
F-4	3	C-4	0	O-4	7			

[113] Ibid., p. 40.

[114] Ibid.

[115] Ibid., p. 42.

		C-5 0			
		C-6 0			
		C-7 0			
Cumulative total	4	2	19	0	25
Points total possible	2/4	2/7	4/4	0/3	8/18

Taba, without a doubt, regards the aspect of origin or formulation as the most important. No mention is made of structural aspects, little of characteristics; and of functions, only explanation is really hit upon.

9. Isaac Quillen--Education for Social Competence; the Social Studies in the Secondary School[116]

Quillen along with the joint author, Lavone Hanna, begins his discussion of hypothesis by quoting Dewey:

> . . . he must use one hypothesis after another as leads in searching for factual material (F-2) which will resolve the doubt, settle and dispose of the perplexity (F-4) . . . he must develop by reasoning (O-4) the idea which offers the best possible solution (F-4).[117]

Quillen then stipulates that,

> . . . the class should analyze the problem in detail and state tentative hypotheses (C-6) as to possible solutions (F-4) before (C-2) they go on to the most important part of problem solving: collecting, evaluating, organizing, and interpreting data which bear upon the problem (F-2).
>
> . . . After students have recognized and defined a problem, the next step is to analyze it into its important subproblems and elements so that hypotheses may be formulated and a plan for studying the problem developed.[118]

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[116] I. James Quillen and Lavone A. Hanna, Education for Social Competence; the Social Studies in the Secondary School (Chicago: Scott, Foresman, 1961).

[117] Ibid., p. 156.

[118] Ibid., p. 176.

He continues,

> When students have analyzed the problem and developed a plan of action for studying it, they should begin to formulate tentative (C-6) hypotheses concerning its solution (F-4). Framing hypotheses means stating possible (C-7) solution(s) (F-4) to the problem. For example, at the beginning of a unit on "How can a high level of prosperity be maintained?" a student might state that depressions are caused by a lack of consumer purchasing power. This is a hypothesis that demands verification (C-1).[119]

Quillen concludes his account of hypothesizing by explicating the basis for hypotheses,

> Hypotheses are often based on knowledge that a student has acquired previously or from the preliminary study that has been done in the introduction of a unit (O-1). . . . Some of the hypotheses or intelligent guesses (O-3) may be discarded almost immediately as impractical, too expensive, or not worthy of consideration (C-7), but others cannot be accepted or rejected without careful study (O-4; (C-1).[120]

<u>Summary</u>:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	0	C-1	2	O-1	1	S-1	0	
	F-2	2	C-2	1	O-2	0	S-2	0	
	F-3	0	C-3	0	O-3	1	S-3	0	
	F-4	5	C-4	0	O-4	2			
			C-5	0					
			C-6	2					
			C-7	2					
Cumulative total		7		7		4		0	18
<u>Points</u> total possible		2/4		4/7		3/4		0/3	9/18

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[119] <u>Ibid</u>., p. 178.

[120] <u>Ibid</u>.

Quillen's analysis resembles Taba's rather closely. Structure is neglected, while a similar emphasis on the explanation function is noted. However, less stress on origin with greater explication of various characteristics is made by Quillen.

10. James Lindberg--Developing Problem-Solving Skills[121]

Contributing a section to the compilation, Teaching the Social Studies, What, Why and How, Lindberg applies the problem-solving process to geography. His second step involves,

> The formulation of tentative (C-6) explanations (F-4) or hypotheses, either from theory (O-1), or from similar situations in the past (O-1), or simply from intuition (O-3).[122]

He, as well, says of hypotheses,

> Normally . . . explanations will involve several different factors operating simultaneously, and the resultant hypothesis will be "multi-variant" in nature (S-1).[123]

Continuing to look at the hypothesis "base" and means of formulation, Lindberg considers requisite,

> . . . a good deal of prior investigation and thought (O-1). The results of this prior work can be brought together in the form of a body of generalizations, laws, and theories stating the relationships involved

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[121]James Lindberg, "Developing Problem-Solving Skills," Social Education, XXX (December, 1966), 645-48, (compiled in) Teaching the Social Studies, What, Why and How, eds., R. E. Gross, Walter E. McPhie, and Jack R. Fraenkel (Scranton, Pa.: International Textbook Company, 1969).

[122]Ibid., p. 283.

[123]Ibid.

> (O-1). By reference to this body of theory (O-1), students can arrive more readily at those types of explanations that others have found to be more valid or have thought to be valid (C-7). . . . Applying this generalization to the particular facts of the problem at hand leads the student quickly and surely to appropriate solutions (F-1; O-2; F-4).[124]

He then retracts somewhat, allowing for the other major source,

> In some cases, a suitable body of theory may not be available for solving the problem at hand, or it may be so poorly developed as not to be applicable. In such a situation alternative procedures must be adopted. One such procedure might be termed "trial and error" (O-3).[125]

Lindberg soundly concludes,

> Thus, it is seen that problem solving becomes a continual inter-play between fact and theory (F-1). Clues to problems are provided by the deductions of theory (O-1), and valid solutions (F-4) to problems are the means by which generalizations and theory are made more "real" and applicable (F-1; O-4).[126]

<u>Summary</u>:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	3	C-1	0	O-1	6	S-1	1	
	F-2	0	C-2	0	O-2	1	S-2	0	
	F-3	0	C-3	0	O-3	2	S-3	0	
	F-4	0	C-4	0	O-4	1			
			C-5	0					
			C-6	1					
			C-7	1					
Cumulative total		6		2		10		1	19

[124] <u>Ibid</u>.

[125] <u>Ibid</u>., p. 286.

[126] <u>Ibid</u>., p. 287.

Points total possible	2/4	2/7	4/4	1/3	9/18

Developing Problem-solving Skills focuses on the aspects of function and origin, with just fleeting reference to the other two components. Lindberg emphasizes the linking and explaining functions, as well as the need for a knowledge basis.

11. Helen Sagl--Problem Solving, Inquiry, Discovery[127]

About inquiry and hypothesizing, Sagl, writing in the same book as Lindberg, says,

> Some problems have no certain answers (C-6). But inquiry into such problems produces insight into their causes and opens new channels of thought about them. Inquiry, in essence, is a process in which children zero in on a problem and hypothesize and formulate theories that get at the areas of why and how (F-4). The focus is not on established generalizations but on theories that predict (F-3) what would happen when put to the test (C-1).
>
> In the process of formulating their theories, learners draw on their own storehouses of conceptual ideas (O-1), speculate and experiment (O-3), as well as look for data that are appropriate to their theories (O-2; F-2).[128]

Summary:

Components

Function		Character-istics		Origin		Structure		Composite Score
F-1	0	C-1	1	O-1	1	S-1	0	
F-2	1	C-2	0	O-2	1	S-2	0	
F-3	1	C-3	0	O-3	1	S-3	0	
F-4	1	C-4	0	O-3	0			

[127] Helen Sagl, "Problem Solving, Inquiry, Discovery," Childhood Education, XCIII (November, 1966), 137-41, (compiled in) Teaching the Social Studies What, Why and How, eds., R. E. Gross, Walter E. McPhie, and Jack R. Fraenkel (Scranton, Pa.: International Textbook Company, 1969).

[128] Ibid., p. 225.

		C-5 0			
		C-6 1			
		C-7 0			
Cumulative total	3	2	3	0	8
Points total possible	3/4	2/7	3/4	0/3	8/18

Sagl little more than implies certain aspects of function, characteristics, and origin, and makes no mention of structural requirements.

12. Joe Park--Three Views of the Problem of Instruction[129]

Park, the one remaining contributor to Teaching the Social Studies, What, Why and How, outlines what he considers to be the steps involved in the scientific method or reflective process.

> (1) Perplexity, confusion, doubt, due to the fact that one is implicated in an incomplete situation whose full characteris not yet known. This is called a problem situation.
>
> (2) A conjectural anticipation--a tentative interpretation (C-6) of the given elements, attributing them to a tendency to effect certain consequences (hypotheses) (C-1).
>
> (3) A careful study of all attainable considerations which will define and clarify the problem at hand (the rightful place of facts) (O-1; O-2).
>
> (4) A consequent elaboration of the tentative hypothesis to make it more precise (C-3) and more consistent because of squaring with a wider range of facts (reasoning) (O-1; O-4).[130]

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[129]Joe Park, "Three Views of the Problem of Instruction," Social Studies, CII (February, 1961), 54-58 (compiled in) Gross and others, op. cit.

[130]Ibid., p. 139.

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	0	C-1	1	O-1	2	S-1	0	
	F-2	0	C-2	0	O-2	1	S-2	0	
	F-3	0	C-3	1	O-3	0	S-3	0	
	F-4	0	C-4	0	O-4	1			
			C-5	0					
			C-6	1					
			C-7	0					
Cumulative total		0		3		4		3	7
Points total possible		0/4		3/7		3/4		0/3	6/18

Park makes no mention of function or structure, referring only to a few characteristics and features respecting origin.

13. Alan Griffin--Revising the Social Studies[131]

Griffin, here, has some rather general comments on hypothesis in discussing the methodology and structure of the social science disciplines:

> The content of the natural sciences has come into being as men have sought coherent and convincing explanations for certain aspects of human experience which they have found puzzling, anomalous, or contradictory. The method of dealing with such "puzzling states of affairs" has been, of course, to "explain" them; and the process of explanation has normally been simply to make up statements which if true (C-6), would adequately account for whatever anomaly or seeming contradiction has disturbed us (F-4). Such statements are given the name "hypotheses"; and every scientist worthy of the name, as soon as he has thought of an "adequate" hypothesis (one which if it should turn out to be "true"--or "warranted"--would account for the otherwise baffling state of affairs that gave

[131]Alan Griffin, "Revising the Social Studies," Social Education, XXXVII (October, 1963), 294.

> rise to it) (F-4), goes to work with all his might to prove it wrong (C-1). A hypothesis that stands up against his every effort to explode it may seem to him worth publishing--merely as a hypothesis, to be sure--so that others in the field may join in the task of teasing out its implications (O-4) and seeing whether they are borne out in actual experience (as they must be if the hypothesis is to be accounted true) (C-1). No amount of such "checking out," of course, can demonstrate conclusively the truth of a hypothesis (C-5) but the failure of protracted efforts to disprove it is certain steadily to increase our confidence in its soundness until, at last, we conclude that, for the present and for an indefinite (though in no sense "delimited") future, it deserves to be classified as an item of "knowledge" (F-1).[132]

Griffin endorses the "level of abstraction thesis" of Chapter 2 (F-1) in the following passage,

> Within each of the natural sciences, considered separately, there exists a substantial body of knowledge so organized that virtually all of the statements which collectively constitute the discipline are related to other statements within the discipline in two distinct ways. Each statement is directly related (1) to one or more statements at a higher level of abstraction for whose truth it stands as "evidence" or "grounds," and (2) to a number of more concrete statements, which it may be said to "generalize" or "subsume," and for which it constitutes a "meaning." In short, any natural science (as a body of knowledge) consists of a body of statements, wholly consistent (so far as is now known) with one another, within which the more abstract furnish "explanations" of apparent contradictions or discrepancies among the less abstract, while the latter provide reasons for believing the former (F-1; O-1).[133]

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[132] Ibid.

[133] Ibid.

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	2	C-1	2	O-1	1	S-1	0	
	F-2	0	C-2	0	O-2	0	S-2	0	
	F-3	0	C-3	0	O-3	0	S-3	0	
	F-4	2	C-4	0	O-4	1			
			C-5	1					
			C-6	1					
			C-7	0					
Cumulative total		4		4		2		0	10
Points total possible		2/4		3/7		2/4		0/3	7/18

Griffin in this article, Revising the Social Studies, mentions about half of the schema points for function, characteristics, and origin. He, however, says nothing of structure.

14. Frank Estvan--Social Studies in a Changing World; Curriculum and Instruction[134]

Estvan begins by listing the formulation of hypotheses as one step in the discovery method. He then holds that this discovery, ". . . depends on the ability to analyze, synthesize, and note relationships (O-4).[135]

He subsequently constructs what he refers to as an "observation checklist" for evaluating elements of problem-solving:

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[134]Frank J. Estvan, Social Studies in a Changing World; Curriculum and Instruction (New York: Harcourt, Brace and World, 1968).

[135]Ibid., p. 366.

A number of specific factors can be considered in connection with the pupil's formulation of hypotheses:

Does the pupil
- (a) advance a number of hypotheses for the solution of a problem (quantity)?
- (b) advance hypotheses quickly and readily (fluency)?
- (c) draw upon past experiences in formulating hypotheses (O-1)?
- (d) use logical methods (syllogism, analogy) in formulating hypotheses (O-4)?
- (e) advance different types of hypotheses (quality) (F-1)?
- (f) advance hypotheses which display unusual insight or creativity (O-3)?[136]

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	1	C-1	0	O-1	1	S-1	0	
	F-2	0	C-2	0	O-2	0	S-2	0	
	F-3	0	C-3	0	O-3	1	S-3	0	
	F-4	0	C-4	0	O-4	2			
			C-5	0					
			C-6	0					
			C-7	0					
Cumulative total		1		0		4		0	5
Points total possible		1/4		0/7		3/4		0/3	4/18

Estvan mentions various facets of origin, saying practically nothing about the other three components.

15. Benjamin Cox--Patterns of Student Behavior[137]

Cox, along with co-author Jack Cousins, places hypothesizing as the second step in a "six phase operational

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[136] Ibid., p. 362.

[137] Benjamin Cox and Jack Cousins, "Patterns of Student Behavior in Reflectively Oriented Classes," Readings on Social Studies in Secondary Education, ed., Jonathan C. Mclendon, New York: Macmillan, 1966.

model of critical thinking."[138] He then proceeds to resort to the findings of the Indiana Experiments in Inquiry.[139] The procedure supposedly practised by students attempting to hypothesize is again recorded. Though limited to the realm of "practice," these findings reveal theoretical influences:

> In the second place, students begin to recognize problems, suggest tentative hypotheses (C-6) as explanations (F-4) for puzzling situations, or establish the meaning of propositions contained in the materials they are using (O-1). This aspect is characterized by free discussion which follows an inductive pattern (O-4). It is stimulated by the teacher, who seeks leading questions, provides additional information (O-1), and encourages widespread participation, so that all possible ideas are generated (O-3). Hypothesizing is always heuristic and often intuitional--that is, there is always a certain amount of "guessing" and discovery involved in forming a hypothesis (O-3).
>
> Third, the problems or hypothesis which have been suggested are explored in depth, so that assumptions and logical implications are made clear (O-4). Again, the students engage in free and largely deductive discussion, in which they challenge each other's logic and use of factual information (O-4). Definitions are subjected to further refinement (C-3).[140]

Summary:

Components

Function		Characteristics		Origin		Structure		Composite Score
F-1	0	C-1	0	O-1	2	S-1	0	
F-2	0	C-2	0	O-2	0	S-2	0	
F-3	0	C-3	1	O-3	2	S-3	0	
F-4	1	C-4	0	O-4	3			
		C-5	0					
		C-6	1					
		C-7	0					

138 Ibid., p. 242.

139 Massialas, Indiana Experiments, op. cit.

140 Cox and Cousins, op. cit., p. 243.

Cumulative total	1	2	7	0	10
Points total possible	1/4	2/7	3/4	0/3	6/18

Like Estvan, Cox stresses features of origin, alluding to only a few aspects of function and characteristics. Again structure is neglected.

16. Daniel Selakovich--Problems in Secondary Social Studies[141]

Selakovich begins by alluding to the need for judging hypotheses offered by the student. He states that it is essential that,

> . . . the teacher is ready, if need be, to question the validity of the hypotheses on the spot (C-7). In this step, whatever technique is employed (O-4), the teacher must see that the hypotheses get thoroughly examined.[142]

Selakovich, however, offers no guidelines for such evaluation

It may be questionable whether he is referring to the scientific hypothesis when he talks of hypotheses that, ". . . might be classified as "common-sense" hypotheses."[143] He elaborates,

> That is, they seem to make sense to the students, containing their own logic (O-4) in the absence of any verifiable evidence to support or reject them. The next step in teaching this particular problem is to collect data which will support or reject the hypotheses that have been represented (C-1; O-2).[144]

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[141]Daniel Selakovich, Problems in Secondary Social Studies (N.J.: Prentice Hall, 1965).

[142]Ibid., p. 19.

[143]Ibid., p. 43.

[144]Ibid.

That data not be considered necessary at an earlier stage, namely during formulation, is, on the basis of the present schema, quite erroneous. Initial empirical foundation is as essential as logical consistency. Selakovich, thus, comes close to self-contradiction when he concedes that,

> . . . hypotheses are rarely invented by students (O-3); they come out of the material of his environment (O-2). Unless the student has made a systematic and comprehensive study of the problem (O-2), he is most likely to express the same beliefs about a problem that his parents, his local newspaper, and his neighbors and friends are expressing.[145]

<u>Summary</u>:

Component

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	0	C-1	1	O-1	0	S-1	0	
	F-2	0	C-2	0	O-2	3	S-2	0	
	F-3	0	C-3	0	O-3	1	S-3	0	
	F-4	0	C-4	0	O-4	2			
			C-5	0					
			C-6	0					
			C-7	1					
Cumulative total		0		2		6		0	8
<u>Points</u> total possible		0/4		2/7		3/4		0/3	5/18

17. <u>Frank Simon--A Reconstructive Approach to Problem-Solving in the Social Studies</u>[146]

Simon little more than mentions hypothesizing in the problem-solving process that he proposes:

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[145] <u>Ibid</u>., p. 42.

[146] Frank Simon, <u>A Reconstructive Approach to Problem-Solving in the Social Studies; A Handbook for Inquiry and Post-Inquiry Activity in Social Process</u> (Calgary, Alberta: University of Calgary, 1970).

> Only after a thorough definition of the problem are students prepared to propose hypotheses. At this point, however, as already noted, a student's hypothesis should not be a suggested solution to the problem (F-4), but rather a tentative position (C-1) on the desirability and feasibility of action on the problem [italics not in the original].[147]

It should be pointed out, in regard to this excerpt, that an hypothesis is always a "type" of solution, corresponding to the type of problem being encountered. All Simon is saying, is that the problem of determining desirability and feasibility is a more immediate one. To decide upon immediate "action" a different type of solution will need to be hypothesized. Apart from this, however, it should be emphasized that Simon's special orientation brings about affective considerations, characterized by comparatively less objective requirements.

Summary:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	0	C-1	0	O-1	0	S-1	0	
	F-2	0	C-2	0	O-2	0	S-2	0	
	F-3	0	C-3	0	O-3	0	S-3	0	
	F-4	1	C-4	0	O-4	0			
			C-5	0					
			C-6	1					
			C-7	0					
Cumulative total		1		1		0		0	2
Points total possible		1/4		1/7		0/4		0/3	2/18

Simon alludes to only two points: the function of

[147] *Ibid.*, p. 23.

explanation and the criterion of predictability.

18. Lawrence Metcalf--Some Guidelines for Changing Social Studies Education[148]

Metcalf observes of hypothesizing in the problem-solving process,

> Problem-solving is logical (O-4) and scientific. One cannot rely upon hunches, feelings and intuitions, or even trials and errors for solutions to problems. The intuitions of students may supply them with hypotheses (O-3), but all such ideas must be tested with data (C-1; O-2) before students can learn whether any of their ideas merit the status of belief.[149]

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	0	C-1	1	O-1	0	S-1	0	
	F-2	0	C-2	0	O-2	1	S-2	0	
	F-3	0	C-3	0	O-3	1	S-3	0	
	F-4	0	C-4	0	O-4	1			
			C-5	0					
			C-6	0					
			C-7	0					
Cumulative total		0		1		3		0	4
Points total possible		0/4		1/7		3/4		0/3	4/18

Metcalf makes reference (and only indirectly) to three aspects of origin; all but the point respecting basis in knowledge. The criterion of testability is the only other point dealt with.

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[148] Lawrence E. Metcalf, "Some Guidelines for Changing Social Studies Education," Readings on Social Studies in Secondary Education, ed., Jonathan C. McLendon (New York: Macmillan, 1966).

[149] Ibid., p. 383.

19. Mark Krug--History and the Social Sciences[150]

Krug, considering hypothesizing as the third step of the inquiry process, simply states,

> The hypotheses determine, in a large measure, the direction of the study (F-2). They also serve as standards for the testing of the finding of the study (F-3; C-1).[151]

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	0	C-1	1	O-1	0	S-1	0	
	F-2	1	C-2	0	O-2	0	S-2	0	
	F-3	1	C-3	0	O-3	0	S-3	0	
	F-4	0	C-4	0	O-4	0			
			C-5	0					
			C-6	0					
			C-7	0					
Cumulative total		2		1		0		0	3
Points total possible		2/4		1/7		0/4		0/3	3/18

Krug looks at only the guiding and predicting functions, along with the characteristic of testability.

20. Irving Sigel--Concepts, Structure, and Learning[152]

This chapter in Morrissett's book, Concepts and Structure in the New Social Science Curricula, gives only very terse treatment of the most critical component of inquiry.

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[150] Mark M. Krug, History and the Social Sciences (Waltham, Mass.: Blaisdell, 1967).

[151] Ibid., p. 109.

[152] Irving Sigel, "Concepts, Structure and Learning," Concepts and Structure in the New Social Science Curricula, ed., Irving Morrissett (New York: Holt, Rinehart and Winston, 1967).

Sigel is merely concerned with the capacity of the child to formulate hypotheses:

> . . . the child is ready to start thinking in formal terms: to generalize and construct hypotheses on the basis of observations (O-2), to make deductions from hypotheses (O-4), and to test the deductions and modify hypothesis on the basis of observations (O-2), to make deductions from hypotheses (O-4), and to test the deductions (C-1) and modify hypotheses (O-4) on the basis of further observations (O-2).[153]

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	0	C-1	1	O-1	0	S-1	0	
	F-2	0	C-2	0	O-2	3	S-2	0	
	F-3	0	C-3	0	O-3	0	S-3	0	
	F-4	0	C-4	0	O-4	3			
			C-5	0					
			C-6	0					
			C-7	0					
Cumulative total		0		1		6		0	7
Points total possible		0/4		1/7		2/4		0/3	3/18

Sigel, in this contribution, apart from a reference to the need for testability, stresses only two points, both on origin: adherence to subject-matter, and systematic inference or reasoning.

21. Gary Manson--Inquiry: Does it Teach How or What to Think?[154]

Manson, writing with Elmer Williams, talks of the

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[153] Ibid., p. 83.

[154] Gary A. Manson and Elmer D. Williams, "Inquiry: Does it Teach How or What to Think?" Social Education, XXXIV (January, 1970), 78-81.

chief raison d'être for hypothesis:

> To investigate, to analyze, to validate, to reflect and to solve (F-2; F-4) requires the generation of additional information beyond that which is given (O-3). . . . the student is expected to ask questions, to formulate hypotheses, to search for additional data (F-2), to draw inferences (O-4) and to reach tentative conclusions (C-6).[155]

Summary:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	0	C-1	0	O-1	0	S-1	0	
	F-2	2	C-2	0	O-2	0	S-2	0	
	F-3	0	C-3	0	O-3	1	S-3	0	
	F-4	1	C-4	0	O-4	1			
			C-5	0					
			C-6	1					
			C-7	0					
Cumulative total		3		1		2		0	6
Points total possible		2/4		1/7		2/4		0/3	5/18

In this paper Manson alludes to several points, none having to do with structure. Apparently he considers the guiding function as the most important.

22. Everett Wilson--The Inductive Orientation in Teaching Sociology[156]

Wilson in this article refers to the requirements of carrying out "real empirical investigations":

> To sociologists and high school teachers designing our materials we said, ". . . all S.R.S.S. materials

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[155] Ibid., p. 79.

[156] Everett K. Wilson, "The Inductive Orientation in Teaching Sociology," High School Journal, CIII, No. 3 (November, 1969), 122-31.

> must be organized around the data of actual empirical investigations (O-2), investigations which point toward significant theoretical conclusions (F-1)." This means in concrete terms, (1) starting with questions, including above all the student's questions, (2) thinking through to plausible answers (F-4; C-7), the hypotheses initially proffered.[157]

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	1	C-1	0	O-1	0	S-1	0	
	F-2	0	C-2	0	O-2	1	S-2	0	
	F-3	0	C-3	0	O-3	0	S-3	0	
	F-4	1	C-4	0	O-4	0			
			C-5	0					
			C-6	0					
			C-7	1					
Cumulative total		2		1		1		0	4
Points total possible		2/4		1/7		1/4		0/3	4/18

Wilson also mentions several points pertaining to the first three components; but, structure is again overlooked.

23. Stanley P. Wronski--A Proposed Breakthrough for the Social Studies[158]

Wronski says, in reference to the standard use of scientific method in the social sciences,

> . . . it consists of rigorous delimitation of some identifiable segment of the whole area of human relationships, posing carefully worded hypotheses (C-3) about the segment, gathering verifiable data (O-2) to test these

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[157] Ibid., p. 122.

[158] Stanley P. Wronski, "A Proposed Breakthrough for the Social Studies," Readings on Social Studies in Secondary Education, ed., Jonathan C. Mclendon (New York: Macmillan, 1966).

> hypotheses (C-1), and reaching some conclusions or generalizations (F-1).[159]

Summary:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	1	C-1	1	O-1	0	S-1	0	
	F-2	0	C-2	0	O-2	1	S-2	0	
	F-3	0	C-3	1	O-3	0	S-3	0	
	F-4	0	C-4	0	O-4	0			
			C-5	0					
			C-6	0					
			C-7	0					
Cumulative total		1		2		1		0	4
Points total possible		1/4		2/7		1/4		0/3	4/18

In this paper, Wronski, as many of the others, in making reference to several of the schema points, ignores the structure component.

24. Wayne Mahood--Opening Up the Closed Areas of Economics[160]

Mahood, writing in the book, The Social Studies; Structure, Models and Strategies, holds that,

> The reflective method entails casting doubt on a dominant belief; using hypotheses which can be tested (C-1) by all the pertinent evidence available (O-2), which is observable, conducive to experimentation, and publicly verifiable (O-1).[161]

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[159] Ibid., p. 271.

[160] Wayne Mahood, "Opening Up the Closed Areas of Economics," The Social Studies; Structure; Models and Strategies, eds., Martin Feldman and Eli Seifman (Englewood Cliffs, N.J.: Prentice-Hall, 1969).

[161] Ibid., p. 303.

Summary:

Components

	Function		Characteristics		Origin		Structure		Composite Score
	F-1	0	C-1	1	O-1	1	S-1	0	
	F-2	0	C-2	0	O-2	1	S-2	0	
	F-3	0	C-3	0	O-3	0	S-3	0	
	F-4	0	C-4	0	O-4	0			
			C-5	0					
			C-6	0					
			C-7	0					
Cumulative total		0		1		2		0	3
Points total possible		0/4		1/7		2/4		0/3	3/18

In this book, Mahood touches on only three points respecting hypothesizing: the criterion of testability, the necessity of basis in knowledge, and the necessity of basis in the relevant subject-matter.

25. Melvin Tumin--Teaching of Social Science as Method[162]

Tumin merely says, in considering the process "automatically" involved in teaching social science:

> One then formulates hypotheses that direct one's attention to probably relevant factors (F-2).[163]

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[162]Melvin Tumin, "Teaching of Social Science as Method," McLendon (ed.), Readings, op. cit.

[163]Ibid., p. 279.

Summary:

Components

	Function		Character-istics		Origin		Structure		Composite Score
	F-1	0	C-1	0	O-1	0	S-1	0	
	F-2	1	C-2	0	O-2	0	S-2	0	
	F-3	0	C-3	0	O-3	0	S-3	0	
	F-4	0	C-4	0	O-4	0			
			C-5	0					
			C-6	0					
			C-7	0					
Cumulative total		1		0		0		0	1
Points total possible		1/4		0/7		0/4		0/3	1/18

In this work, Tumin notes but one of the schema points, namely the function of guiding or directing.

SUMMARY

A complete summary of all the data produced in the foregoing analysis is laid out in Table 1 (pp. 153, 154). Ease of comparison, subsequent rating of writers and selections, as well as the calculation of "coverage" of both general components and individual schema points is facilitated by this synthesis.

From this table conclusions regarding the rating of writers and the overall treatment of schema components and points, as well as a general evaluation of these analyses of the concept, hypothesis, will be made in the final chapter.

Table 1

SUMMARY TABLE FOR CALCULATIONS OF SCHEMA POINTS

	1 Byran Massialas							2 Maurice Hunt	3 Bernice Goldmark	4 Charlotte Crabtree			5 S.R.S.S.	6 David Kellum	7 Edwin Fenton				8 Hilda Taba	9 Isaac Quillen	10 James Lindberg	11 Helen Sag;	12 Joe Park
	Inquiry in S. S.*	Indiana Experiments	Reflective Model	Creative Encounters	S. S. Through Discovery	History as Inquiry	Total	Teaching High School Social Studies	Social Studies; A Method of Inquiry	Reflective Thinking	Inquiry Approaches	Total	Testing for Truth: A Study of Hypothesis Evaluation	The Social Studies, Myths and Realities	The New S. S.	New S. S. in Sec. Schools	Developing Inquiry Skills	Total	Implementing Thinking as an Objective in Social Studies	Education for Social Competence; the S. S. in the Secondary Schools	Developing Problem Solving Skills	Problem Solving, Inquiry, Discovery	Three Views of the Problem of Instruction
Function																							
F-1	4	0	1	1	0	2	8	2	1	0	1	1	1	1	0	0	1	1	1	0	3	0	0
F-2	5	0	1	3	0	0	9	1	7	5	0	5	0	3	4	1	0	4	0	2	0	1	0
F-3	0	0	0	0	0	0	0	0	8	1	0	1	5	0	0	0	0	0	0	0	0	1	0
F-4	4	3	2	2	0	2	13	1	4	1	1	2	1	1	1	2	0	3	3	5	3	1	0
Cum. Tot.	13	3	4	6	0	4	30	4	20	7	2	9	7	5	5	3	1	8	4	7	6	3	0
Pts/tot. poss.	3/4	1/4	3/4	3/4	0/4	2/4	3/4	3/4	4/4	3/4	2/4	4/4	3/4	3/4	2/4	2/4	1/4	3/4	2/4	2/4	2/4	3/4	0/4
Characteristics																							
C-1	2	0	0	0	0	0	2	9	0	3	0	3	3	0	0	0	0	0	1	2	0	1	1
C-2	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0
C-3	4	1	1	0	0	2	8	3	0	1	0	1	2	0	0	0	0	0	1	0	0	0	1
C-4	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C-5	0	0	0	0	0	0	0	1	3	0	0	0	2	1	0	0	0	0	0	0	0	0	0
C-6	1	0	0	1	0	0	2	0	2	1	1	2	3	2	1	1	1	3	0	2	1	1	1
C-7	1	0	0	0	0	0	1	0	1	0	0	0	3	1	0	0	0	0	0	2	1	0	0
Cum. Tot.	9	1	1	1	0	2	14	14	6	5	1	6	15	4	1	1	1	3	2	7	2	2	3
Pts/tot. poss.	5/7	1/7	1/7	1/7	0/7	1/7	5/7	4/7	3/7	3/7	1/7	3/7	6/7	3/7	1/7	1/7	1/7	1/7	2/7	4/7	2/7	2/7	3/7
Origin																							
O-1	0	2	2	0	2	0	6	6	2	2	1	3	3	1	0	0	2	2	4	1	6	1	2
O-2	3	1	0	0	0	0	4	2	4	3	0	3	2	3	2	1	1	4	4	0	1	1	1
O-3	0	2	0	0	2	0	4	1	1	2	2	4	1	2	0	0	0	0	4	1	2	1	0
O-4	7	2	0	1	2	0	12	7	1	9	2	11	4	4	4	0	1	5	7	2	1	0	1
Cum. Tot.	10	7	2	1	6	0	26	16	8	16	5	21	10	10	6	1	4	11	19	4	10	3	4
Pts/tot. poss.	2/4	4/4	1/4	1/4	3/4	0/4	4/4	4/4	4/4	4/4	3/4	4/4	4/4	4/4	2/4	1/4	3/4	3/4	4/4	3/4	4/4	3/4	3/4
Structure																							
S-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
S-2	1	0	0	2	0	0	3	2	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0
S-3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cum. Tot.	1	0	0	2	0	0	3	4	2	0	0	0	2	0	0	0	0	0	0	0	1	0	0
Pts/tot. poss.	1/3	0/3	0/3	1/3	0/3	0/3	1/3	2/3	1/3	0/3	0/3	0/3	1/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	1/3	0/3	0/3
Composite Scores Cum.	33	11	7	10	6	6	73	38	36	28	8	36	34	19	12	5	6	23	25	18	19	8	7
Composite Scores Pts.	$\frac{11}{18}$	$\frac{6}{18}$	$\frac{5}{18}$	$\frac{6}{18}$	$\frac{3}{18}$	$\frac{3}{18}$	$\frac{13}{18}$	$\frac{13}{18}$	$\frac{12}{18}$	$\frac{10}{18}$	$\frac{6}{18}$	$\frac{11}{18}$	$\frac{14}{18}$	$\frac{10}{18}$	$\frac{5}{18}$	$\frac{4}{18}$	$\frac{5}{18}$	$\frac{7}{18}$	$\frac{8}{18}$	$\frac{9}{18}$	$\frac{9}{18}$	$\frac{8}{18}$	$\frac{6}{18}$

*Many titles, particularly those of "multiple selections" have been abstracted.

Table 1 (continued)

	13 Alan Griffen	14 Frank Estevan	15 Benjamin Cox	16 Daniel Selakovich	17 Frank Simon	18 Lawrence Metcalf	19 Mark Krug	20 Irving Sigel	21 Gary Manson	22 Everett Wilson	23 Stanley Wronski	24 Wayne Mahood	25 Melvin Tumin	Totals		
	Revising the S. Studies	S. S. in a Changing World	Patterns of Student Behavior	Problems in Secondary S. S.	A Reconstructive Approach to Problem-Solving in the S. S.	Some Guidelines for Changing S. S. Education	History and the S. Studies	Concepts, Structure, and Learning	Inquiry: Does it Teach How or What We Think	The Inductive Orientation in Teaching Sociology	A Proposed Breakthrough for the Social Studies	Opening up the Closed Areas of Economics	Teaching of S. S. as Method	Cumulative	Points/total possible	Percentage
Function																
F-1	2	1	0	0	0	0	0	0	0	1	1	0	0	24	13/25	52%
F-2	0	0	0	0	0	0	1	0	2	0	0	0	1	36	11/25	44%
F-3	0	0	0	0	0	0	1	0	0	0	0	0	0	16	5/25	20%
F-4	2	0	1	0	1	0	0	0	1	1	0	0	0	43	16/25	64%
Cum. Tot.	4	1	1	0	1	0	2	0	3	2	1	0	1	119	---	---
Pts/tot. poss.	2/4	1/4	1/4	0/4	1/4	0/4	2/2	0/4	2/4	2/4	1/4	0/4	1/4	---	45/100	45%
Characteristics																
C-1	2	0	0	1	0	1	1	1	0	0	1	1	0	30	15/25	60%
C-2	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	3/25	12%
C-3	0	0	1	0	0	0	0	0	0	0	1	0	0	18	8/25	32%
C-4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1/25	4%
C-5	1	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	5/25	20%
C-6	1	0	1	0	1	0	0	0	1	0	0	0	0	23	15/25	56%
C-7	0	0	0	1	0	0	0	0	0	1	0	0	0	11	8/25	32%
Cum. Tot.	4	0	2	2	1	1	1	1	1	1	2	1	0	95	---	---
Pts/tot. poss.	3/7	0/7	2/7	2/7	1/7	1/7	1/7	1/7	1/7	1/7	2/7	1/7	0/7	---	54/175	31%
Origin																
O-1	1	1	2	0	0	0	0	0	0	0	0	1	0	42	16/25	64%
O-2	0	0	0	3	0	1	0	3	0	1	1	1	0	39	17/25	68%
O-3	0	1	2	1	0	1	0	0	1	0	0	0	0	27	15/25	60%
O-4	1	2	3	2	0	1	0	3	1	0	0	0	0	68	18/25	72%
Cum. Tot.	2	4	7	6	0	3	0	6	2	1	1	2	0	176	---	---
Pts/tot. poss.	2/4	3/4	3/4	3/4	0/4	3/4	0/4	2/4	2/4	1/4	1/4	2/4	0/4	---	66/100	66%
Structure																
S-1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1/25	4%
S-2	0	0	0	0	0	0	0	0	0	0	0	0	0	9	4/25	16%
S-3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1/25	4%
Cum. Tot.	0	0	0	0	0	0	0	0	0	0	0	0	0	12	---	---
Pts/tot. poss.	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	---	6/75	8%
Composite Scores Cum.	10	5	10	8	2	4	3	7	6	4	4	3	1	---	---	---
Composite Scores Pts.	7/18	4/18	6/18	5/18	2/18	4/18	3/18	3/18	5/18	4/18	4/18	3/18	1/18	---	171/18x25	38%

Chapter 4

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The degree of coverage, including stipulations for use, of the concept, hypothesis, it was held, should provide a fairly accurate indication of the significance attributed to the "heart" of the inquiry method used in social studies.

For purposes of this investigation "coverage" is determined by assessing both "quality" and "quantity," that is, by utilizing both cumulative and total individual point scores. Using the composite scores a rating, based on the total number of individual schema points, yields the ranking of social studies writers shown in Table 2.

Table 2

RANKING OF SOCIAL STUDIES WRITERS ON THE BASIS OF INDIVIDUAL POINT TOTALS

S.R.S.S.	14	Cox	6
Massialas	13	Manson	5
Hunt	12	Estvan	4
Goldmark	12	Selakovich	4
Crabtree	11	Metcalf	4
Kellum	10	Wronski	4
Quillen	9	Wilson	4
Lindberg	9	Krug	3

Table 2 (continued)

Taba	8	Sigel	3
Sagl	8	Mahood	3
Fenton	7	Simon	2
Griffin	7	Tumin	1
Park	6		

Now, as suggested, depth or degree of coverage may be more accurately assessed by resorting to cumulative scores. Consideration of the "extent" of treatment revealed by these scores, produces a somewhat modified rank order of the same writers, as per Table 3:

Table 3

RANKING OF SOCIAL STUDIES WRITERS ON THE BASIS OF CUMULATIVE SCORES

Massialas	67	Selakovich	8
Hunt	45	Park	7
Goldmark	36	Sigel	7
Crabtree	36	Manson	6
S.R.S.S.	35	Estvan	5
Taba	25	Metcalf	4
Fenton	23	Wilson	4
Kellum	19	Wronski	4
Lindberg	19	Krug	3
Quillen	18	Mahood	3
Griffen	18	Simon	2
Cox	10	Tumin	1
Sagl	8		

This particular rating, though useful, may in terms of validity be somewhat suspect. That is because certain figures--those for Massialas, Crabtree, and Fenton to be exact--represent a compilation of more than one work. Hence, the size of the score in these cases may be partially attributable to redundancy, where the writers are but reaffirming the same point.

Such misinterpretation could be somewhat circumvented by rating only the individual publications, irrespective of the author. Of course, there is an inherent value in evaluating the publication as well as the contributor. Employing the numbering system used in the summary table, in Table 4 (p. 158), the actual publications are rated by both composite scores.

Respecting the major components of an hypothesis a computation of the overall point coverage for each proves quite revealing. The cumulative addition of the separate points dealt with by each author(s) produces the results shown in Table 5.

Table 5

COVERAGE BY SOCIAL STUDIES WRITERS OF THE MAJOR COMPONENTS OF THE CONCEPT HYPOTHESIS

	Total Covered	Total Possible	Average Points	Per cent
Function	45	100	1.8/4	45
Characteristics (criteria)	54	175	2.1/7	31
Origin	66	100	2.64	66
Structure	6	75	0.23	8
Total	171	450	6.7/18	38

Table 4

RANKING OF SOCIAL STUDIES PUBLICATIONS

Cumulative Score						Total Schema Points					
	Publication	Score		Publication	Score		Publication	Score		Publication	Score
1.	7	38	18.	3	7	1.	11	14	18.	13	5
2.	8	36	19.	20	7	2.	7	13	19.	15	5
3.	11	34	20.	28	7	3.	8	12	20.	24	5
4.	1	33	21.	5	6	4.	1	11	21.	29	5
5.	9	28	22.	6	6	5.	9	10	22.	14	4
6.	16	25	23.	15	6	6.	12	10	23.	22	4
7.	18	19	24.	29	6	7.	17	9	24.	26	4
8.	12	19	25.	14	5	8.	18	9	25.	30	4
9.	17	18	26.	22	5	9.	16	8	26.	31	4
10.	13	12	27.	26	4	10.	19	8	27.	5	3
11.	2	11	28.	30	4	11.	21	7	28.	6	3
12.	4	10	29.	31	4	12.	2	6	29.	27	3
13.	21	10	30.	27	3	13.	4	6	30.	28	3
14.	23	10	31.	32	3	14.	10	6	31.	32	3
15.	10	8	32.	25	2	15.	20	6	32.	25	2
16.	24	8	33.	33	1	16.	23	6	33.	33	1
17.	19	8				17.	3	5			

It is to be recalled that Dewey, speaking generally, considered origin to be most neglected. Evidently these findings from the area of writings on social studies inquiry do not concur with Dewey's observation. In social studies literature, on the basis of the schema constructed, origin is handled most comprehensively, while structure is very noticeably neglected.

As well, the general inadequacy of coverage is most apparent. Basing computation on the produced schema, the above figures reveal that the average rating is only 6.7 points out of a possible 18, or 38 per cent of the total possible.

The inequitable nature of the coverage is further demonstrated by looking at the cumulative totals for the respective components. Origin is analyzed in the greatest depth (176; 4 pts), function is second (119; 4 pts), characteristics third (95; 7 pts), and structure receives practically no attention (12; 3 pts).

What of the total coverage on individual schema points? Functions are moderately well covered, that of explanation receiving the highest rating (16/25 or 64%). However, a function often considered very crucial in the analysis of an hypothesis, that of prediction, is relatively poorly covered (5/25 or 20%).

Contributing characteristics or criteria are generally very inadequately covered by the social studies writers. Particularly the principle of simplicity, a point usually

stressed by logicians, is weakly treated (1/25 or 4%). Two exceptions to this generalization are the criteria of testability (15/25 or 60%) and tentativeness (14/25 or 56%).

Origin, as indicated, is covered most adequately: all four points range between 15 and 18 out of 25, or 60 to 72 per cent.

The component of structure is all but ignored. The requirement of possessing at least two variables has only one proponent (1/25 or 4%); that stipulating a definite relationship between or amongst variables is touched on four times (4/25 or 16%), and the point regarding a common referent and modes of variation is mentioned only once (1/25 or 4%). The question of the reason for the evident lack of concern over this component begs an answer. Could it be that social studies people have simply not been conscious of the need for explicating directions concerning structure? Or could it be that these theorists refuse to recognize this aspect, possibly to avoid unwanted restrictions? If all aspects or points of the schema are indeed necessary for the creation of a truly scientific hypothesis, then these questions demand answers. Further study in the area is, therefore, very much needed.

From the perspective of seeking to measure the exact value or "worth" of each writer respecting the concept hypothesis and the process of hypothesizing, an important qualification must be made. These writers, even though confining their discussion to social studies, have very

different styles, concerns, interests, and emphasis. While some place a special emphasis on the inquiry or problem-solving approach, others may be stressing other aspects of interest to social studies people. The placement of priorities in this regard is dependent upon the primary aim of the publication. Knowing this, it is in a sense unfair to, using the same standard, compare and contrast the work of all these authors in coping with one very specific item, namely the concept, hypothesis.

Nevertheless, it is to be countered that there is a real need to at least generally establish the existing situation. In spite of the necessary quantification, that is strictly all this study has proposed to accomplish. So, a general survey of the situation, that is, a look at secondary social studies theoretical and methodological literature of the past twelve years in North America, reveals that the use and description of the concept, hypothesis, in the problem-solving, inquiry, or discovery processes are seriously inadequate. It can only be conceded that, in view of the requirements of a scientific hypothesis, of the writers analyzed, only a few supply what could be considered adequate treatment.

A corollary point could be phrased and left as a question: If the treatment by theorists and methodologists of this particular concept is inadequate, what of <u>other</u> concepts considered integral to social studies education and even education generally?

RECOMMENDATIONS

General Recommendations

The most direct and immediate suggestion arising from the foregoing conclusions is that more of these social studies writers must become conscious of the crucial position and increasing significance of the concept, hypothesis, in the higher thinking processes. It is then hoped that along with such consciousness would come an awareness of the importance of the explanation and analysis of hypothesis and hypothesizing. Strongly advised, on the basis of the Chapter 2 analysis, are stipulations of identifying characteristics and criteria and equally important descriptions of elements of the concept's functioning, origin, and structure.

Further grounds for the foregoing recommendations can be discovered in viewing the major ramifications. It is evident that inquiry has become a closely adhered to, if misunderstood, approach, constituting the essence of the "new" social studies. Students being taught to use this approach must know how to perform all the operations entailed in the process. Since hypothesizing is inherently the most significant and fundamental, learning the capacity to hypothesize is especially necessary. Further, with inquiry being basically a scientific procedure, it is requisite that the student know how to hypothesize scientifically and systematically. This won't just "happen." For this capability to be acquired, advice and guidance must come from the teacher.

The teacher, in turn, relies on available theory and methodology. To some extent, teachers will rely directly on "curriculum and instruction" instructors for pertinent knowledge. That these instructors be prepared to fully cope with all learning and pedagogical concepts is a necessity. Hence, the importance for the interested writers of fully explicating the concept, hypotheses, is hard to overemphasize.

Recommendations for Research

Outside of limited research in the areas of logic and philosophy (e.g., Buchanan)[1] very little has been done in the way of producing, describing, or classifying thought on the higher thinking processes. Perhaps, therefore, definition and analysis of the higher thinking processes (especially inquiry, due to a noticeable lack here), in spite of the existing obstacles as enumerated in the first chapter, is of paramount importance and should receive first priority. Such research cannot, of course, be made from only a theoretical perspective; controlled investigation of the actual thinking operations of students may prove even more fruitful. If so, purely descriptive research based at the operational level should not be neglected. Of course, one type of research cannot exclude the other; the two types are really functionally inter-related.

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[1]Bruce Gardner Buchanan, "Logics of Scientific Discovery," Dissertation Abstracts, Humanities and Social Sciences, 28 (1966), 256A.

More specific to the problem of this thesis, suggested research would primarily entail an extension of the very type of research exemplified by this study. The present investigation could be considered an initiatory effort. Neither the schema produced, nor the findings obtained from the analysis of social studies writers are exclusive or conclusive. The central purpose, the real intent, of this study was to uncover a perceived need by determining the adequacy of the use of the concept, hypotheses, by social studies theorists. While some definite findings were produced, there is a clear indication that more research both in and beyond social studies is requisite.

Also necessary, to substantiate certain assumptions made in this study, is extensive research at the "implementation" level. Just how well do students hypothesize? As evidenced explicitly by statement, or implicitly by use, what do students and teachers seem to know about hypothesizing? Of course, beyond just assessing the firmness of linkage between theory and practice, questions exemplified by this last one are the real concern of educators everywhere. Only descriptive and experimental research at the "practice" level can provide empirical answers to these questions.

Concluding Remarks

In conclusion let it be said that the significance

of the concept, hypothesis, is unbounded by subject area or discipline. While this study has limited its application to social studies, as initially indicated, hypothesizing is basic to all scientifically productive thinking. The concept really represents a fundamental attitude or state of mind characteristic of true scientific method and, thus, necessary for progress in science--and, consequently, a good part of man's endeavors. To advance, to improve, willingness to go beyond the "given," the state of things as they are now and have been, becomes absolutely essential. In scientific inquiry this disposition necessarily entails the acceptance of a condition of doubt, of uncertainty, and the realization that ideas, suppositions, assumptions, and even "knowledge" can be held only tentatively pending further testing in the empirical world. The extension of the perimeter of what man knows is dependent on this very attitude.

This is what hypothesizing is all about; herein lies its real significance. It is hoped, therefore, that more people in social studies, but even more importantly, all thinkers responsible for the advancement of man's state of knowledge, will become more conscious of this significance. Then, it is hoped, this consciousness will become more evidenced in both theory and practice.

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